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Abstract

Shifting individual behaviour is an important tool for addressing environmental issues and there is a wide literature evaluating interventions to encourage pro-environmental behaviour. One important but under-researched area is the effect of combining interventions to affect behaviour. In this paper, we evaluate the effects of two interventions – monetary incentives and nudges – on nature restoration volunteering. We use a two-by-two treatment design to evaluate the individual and combined effects of the interventions in a field experiment setting. We find that the monetary incentive significantly increases volunteering behaviour, despite concerns incentives may crowd out motivation, but that nudging alone is ineffective at shifting behaviour. However, there are considerable positive synergies between the monetary incentive and nudge. The monetary incentive becomes more than twice as effective when it is combined with a nudge. We find support for our theoretical prediction that this synergy arises because the nudge reduces motivational crowding out effects from the incentive. Our results have important policy implications, showing that concerns around motivation crowding out from monetary incentives could be mitigated by simple, low-cost nudges.

Keywords: Field experiment, incentive, nature restoration, nudge, PEB, pro-environmental behaviour, synergy, volunteering

JEL codes: C93, D91, Q57

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1. Introduction

Shifting individual behaviour is one important tool for addressing environmental issues like climate change and environmental degradation. Indeed, extensive work has investigated the drivers and levers of pro-environmental behaviours (for recent examples, see Bonan et al., 2021; Carlsson et al., 2021; Zemo & Termansen, 2022). Nudges and monetary incentives are two of the most common interventions to affect pro-environmental behaviour (Carlsson et al., 2021; Maki et al., 2016; Schubert, 2017; Sloot & Scheibehenne, 2022). Nudges are defined as a change in the decision environment to alter individual decisions, without changing the choices available or significantly changing the economic incentives (Thaler & Sunstein, 2009). Although monetary incentives may be the standard solution for an economist, and indeed incentives can affect pro-environmental behaviour (Diederich & Goeschl, 2017; Maki et al., 2016; Viscusi et al., 2011), there have been concerns about motivational crowding out through the use of incentives in certain contexts (Gneezy et al., 2011; Ling & Xu, 2021; Rode et al., 2015). On the other hand, nudges, such as the use of defaults or injunctive norm messages, can be an effective way to shift behaviour in some contexts, but less effective in other contexts (Carlsson et al., 2021; DellaVigna & Linos, 2022; Gravert & Olsson Collentine, 2021; Szaszi et al., 2022).

Naturally, policies can be combined, and it is of interest to find out if and how there are synergies between them (Al-Ubaydli et al., 2017; Brent et al., 2015; Gravert & Olsson Collentine, 2021; List et al., 2017). For example, in many cases nudges are a relatively low-cost intervention, so if a nudge reduces motivational crowding out of a monetary incentive, then it might be efficient to combine the two. Indeed, authors have pointed to the importance of using nudges to make Pigouvian pricing policies effective (Dorner, 2023; Gravert & Shreedhar, 2022). Recently, Chan (2024) developed a theoretical model that shows the interaction between Pigouvian policies and behavioural factors, including nudges, social norms and spillovers. However, there is limited empirical evidence on the effects of combining nudges and monetary incentives (Drews et al., 2020). Do synergies exist between nudges and financial incentives? Can nudges enhance the efficacy of incentives? Or will they detract from the effects of the incentive?

Overall, Drews et al. (2020) concludes that there is a small body of evidence on the synergies between nudges and incentives and there is little evidence for the existence of either positive or negative synergies (most studies suggest no synergies). Moreover, almost all of the existing

studies in this space focus on electricity, energy, or water use, a common feature of the experimental literature in environmental economics (Brent et al., 2017). Of the few experimental studies that examine synergies between nudges and incentives, the results are mixed. Two studies, one on food choice and one on fuel-efficient driving, find no synergies between nudges and incentives (Panzone et al., 2021; Schall et al., 2016). A more recent experimental paper also finds no synergies (Fanghella et al., 2021). On the other hand, Hilton et al. (2014) shows a positive synergy between nudges and incentives in a hypothetical transportation decision scenario amongst a population of students. Again though, the specificity of matching the nudge to the context and behaviour in order for it to be successful means that more work needs to be done in this area (Drews et al., 2020; van Valkengoed et al., 2022).

The importance of understanding synergies between nudges and incentives matters not just for short-term policy success, but also for the long-term effects of interventions (Drews et al., 2020). For example, if synergies are driven by changes in underlying pro-environmental motivation, this could have broader implications for environmental policy support (Gravert & Shreedhar, 2022). Most studies that consider the potential synergies speculate that this is driven by motivational crowding in (or out). There could be "incentive crowding" effects where the nudge impacts the efficacy of the incentive; for example, by highlighting the pecuniary and non-pecuniary benefits of the incentive, which strengthens the incentive treatment effect (Drews et al., 2020). Monetary incentive could also crowd out (or in) intrinsic motivation (for one of several reasons – see Frey & Jegen, 2001; Rode et al., 2015) and that could impact the efficacy of the nudge (Hilton et al., 2014; Martin & Rivers, 2018; Schall et al., 2016). Few studies have empirically assessed the mechanism driving synergies (or the lack thereof). One exception is a recent paper on energy conservation by Fanghella et al. (2021) where the authors run treatment-values interactions to essentially rule out motivational crowding effects as a mechanism in their context.

In this paper, we report on the findings from a field experiment where we test for synergies in a nudge and monetary incentive for first-time volunteering for a nature restoration group in Aotearoa New Zealand. We use a two-by-two design to evaluate the effects of a nudge, monetary incentive, and combined treatment on volunteering behaviour. We also illustrate with a simple model how to think about the mechanism underlying potential synergies, building on the model of intrinsic and extrinsic motivation by Bowles & Polania-Reyes (2012). We also empirically explore the mechanisms using attitudinal data. This is an area that is important to understand from a policy perspective (Drews et al., 2020) and one that very few studies have

been able to interrogate (a notable exception being Fanghella et al., 2021). Finally, we add to the limited experimental literature on interventions that can increase *nature conservation* behaviours. As Nielsen et al. (2021) asserts, nature conservation is an important and under-researched area in the behavioural science literature. Moreover, most studies on PEBs in the environmental economics literature focus on energy or water consumption, likely because these are more readily observable in data (Brent et al., 2017).

Indeed, there is not just a gap in the literature on nudge-incentive synergies, but there is also a considerable shortage of behavioural science research that focuses on behaviours that directly impact nature and biodiversity (Brent et al., 2017; Grilli & Curtis, 2021; Nielsen et al., 2021). This is concerning, given the enormous value populations place on nature, the fundamental role nature plays in society and because nature is declining rapidly. Volunteering for nature restoration groups is an impactful behaviour (in terms of environmental outcomes) that few people are engaged in, even though it creates significant benefits for society and the volunteers themselves (Ganzevoort & van den Born, 2020; Meier & Stutzer, 2008; Nielsen et al., 2021; R. L. Ryan et al., 2001). Moreover, we focus on the urban population because few studies focus on behaviours for biodiversity conservation and even fewer study them in an urban context (Brent et al., 2017; Nielsen et al., 2021; Truelove et al., 2014). We also select our target behaviour through an explicit selection approach which prioritises the behaviours most impactful for end outcomes, which is uncommon but highly recommended in the literature (Al-Ubaydli et al., 2017; Nielsen et al., 2021).

We find that the nudge alone has no effect on volunteering compared with the control, while the monetary incentive in terms of a vouchers increases volunteering relative to the control. However, when we combine the two treatments, the total treatment effect is significantly greater than the sum of the individual effects of the nudge and incentive. This shows that there are significant positive synergies between nudges and incentives in this context. Based on our theoretical understanding of how synergies could arise, we find that the positive synergy is likely driven by motivational crowding effects from the voucher, which are offset through the use of the nudge. This has important implications for those thinking of designing voucher programmes to encourage the uptake of pro-environmental behaviours.

The rest of the paper is organized as follows. In section 2 we outline the experimental design. In section 3 we outline a simple model illustrating how nudges and monetary incentives affect

behaviour, and in section 4 we present our three main hypotheses. In section 5 we present the data, and in section 6 we present our results. Finally, in section 7 we discuss our results.

2. Experimental design

Our field experiment aimed to increase participation in volunteering for nature restoration groups. The experiment was approved by the Waikato Management School (WMS) Human Research Ethics Committee, application number: WMS 22/134. Moreover, we pre-registered our hypotheses and analyses before carrying out the experimental design on AsPredicted.[1] We designed three treatments (a nudge, a voucher and a combined nudge and voucher) that aimed to reduce barriers and uncertainty and incentivise participation in volunteering activities. We aimed to evaluate how effective these treatments are at encouraging first-time volunteering relative to a control group and evaluate how the combined treatment fares in relation to the individual nudge and voucher treatments. Our experimental design is summarised in Figure 1.

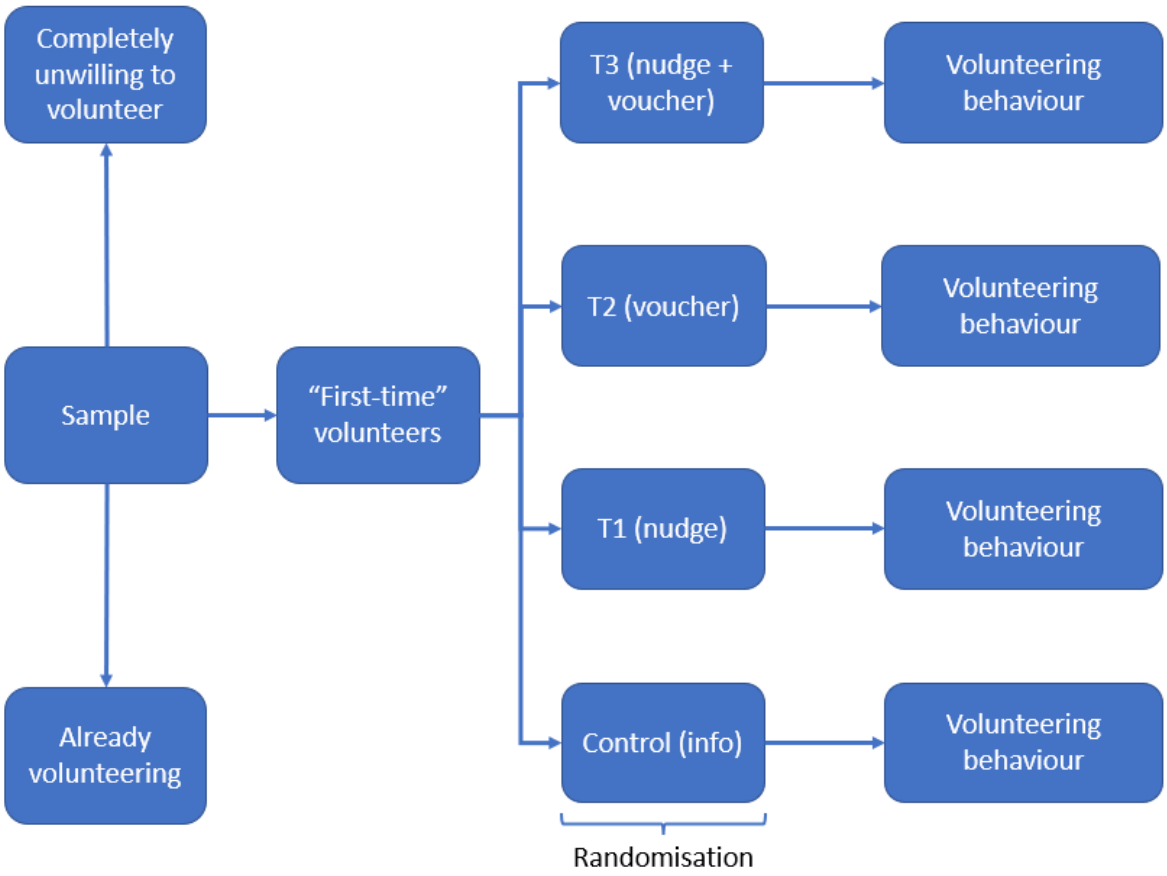

Figure 1. Experimental design

[1] The pre-registration #119297 is titled: "Volunteering for restoration groups - Field experiment" and is publicly available at the following link: https://aspredicted.org/qi57d.pdf.

We recruited a sample of first-time time-volunteers using an online survey administered through the Qualtrics platform targeted at first-time volunteers residing in or near Hamilton, New Zealand. The recruitment strategy included a prize draw consisting of five NZD 100 Prezzy cards (the draw was conducted after the study was completed). Subjects were asked to fill out a survey; a copy of the full survey can be found in the Appendix. Within this survey, we randomly assigned individuals identified as potential time first-time volunteers to one of four groups, as per Figure 1.

After answering all demographics and environmental attitudes questions, respondents were asked whether they would like to pre-commit to a volunteering event sometime over the next month and specify days they may be available. This is a stated preference variable that we call "pre-commitment" because individuals are committing to attend but have not yet committed to a specific date or time; see Figure 2. Based on treatment group status, individuals received variations of the question about pre-committing to an event; we describe the treatments in detail in the next section. Immediately following random assignment, we asked individuals whether they would be willing to sign up for a nature volunteering event.

After survey completion (between 20/01/2023 and 22/02/2023), we reached out to all pre-committed individuals asking them to confirm whether they would attend one of two volunteering events.[2] We called this variable "commitment" because we asked individuals to confirm their attendance at a specific event and inform us how many family members would be attending with them. We collected this information through another short survey (the commitment survey – a copy can be found in the Appendix). Finally, we observed whether individuals attend a volunteering event, denoting this variable as "attendance." We evaluated whether the treatments have any effects on all three measures of willingness to volunteer.

[2] There were four events in total, but individuals were only offered a choice between two events. This was to keep those receiving vouchers and not receiving vouchers separate throughout the experiment.

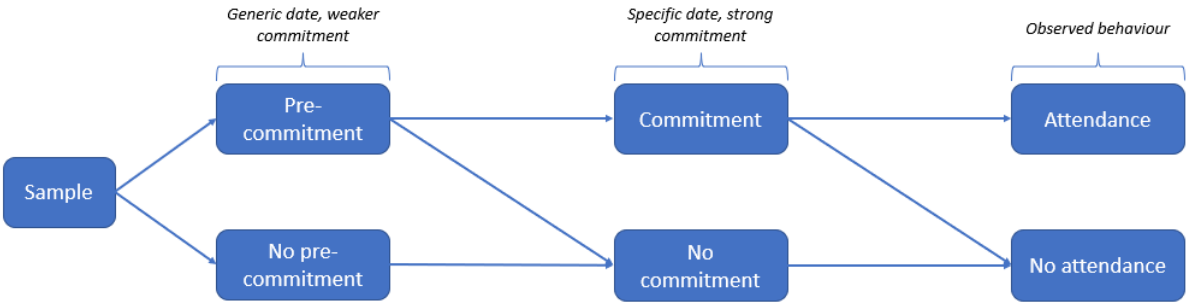

Figure 2. Outcome volunteering variables. Pre-commitment is a general commitment to attend a volunteering event in the next four weeks. Commitment is a commitment to attend a specific event and attendance is actual attendance at an event.

2.1.Experiment treatments

Based on treatment group status, individuals received variations of the question about pre-committing to an event at the end of the survey. All respondents received the same baseline information with details about the length and type of event. This baseline information formed the conditions for the control group.

For the nudge group, we included a statement designed to make environmental and social benefits more salient when individuals make their decision to pre-commit to an event. The nudge differs from the control by specifically referencing the social and environmental benefits of volunteering, which engages individuals with pro-environmental and pro-social motivations.

For the voucher group, individuals received a one-off NZ $50 supermarket voucher for attending. This is equivalent to 1.3 hours of work based on the national average hourly earnings during the March 2023 quarter (Stats NZ, 2023). The voucher was not meant to fully compensate individuals for their time. Rather, the voucher is a way of helping individuals experiment with a new and uncertain behaviour. We carefully framed the voucher to reduce the risk of crowding out of intrinsic motivation by specifically referencing that the voucher is a one-off payment to support people trying something new (Gneezy et al., 2011).

In Figure 3, we show what the question looked like for someone randomly assigned to the combined treatment group. We have highlighted the specific components of the question that constitute the nudge and voucher offer.

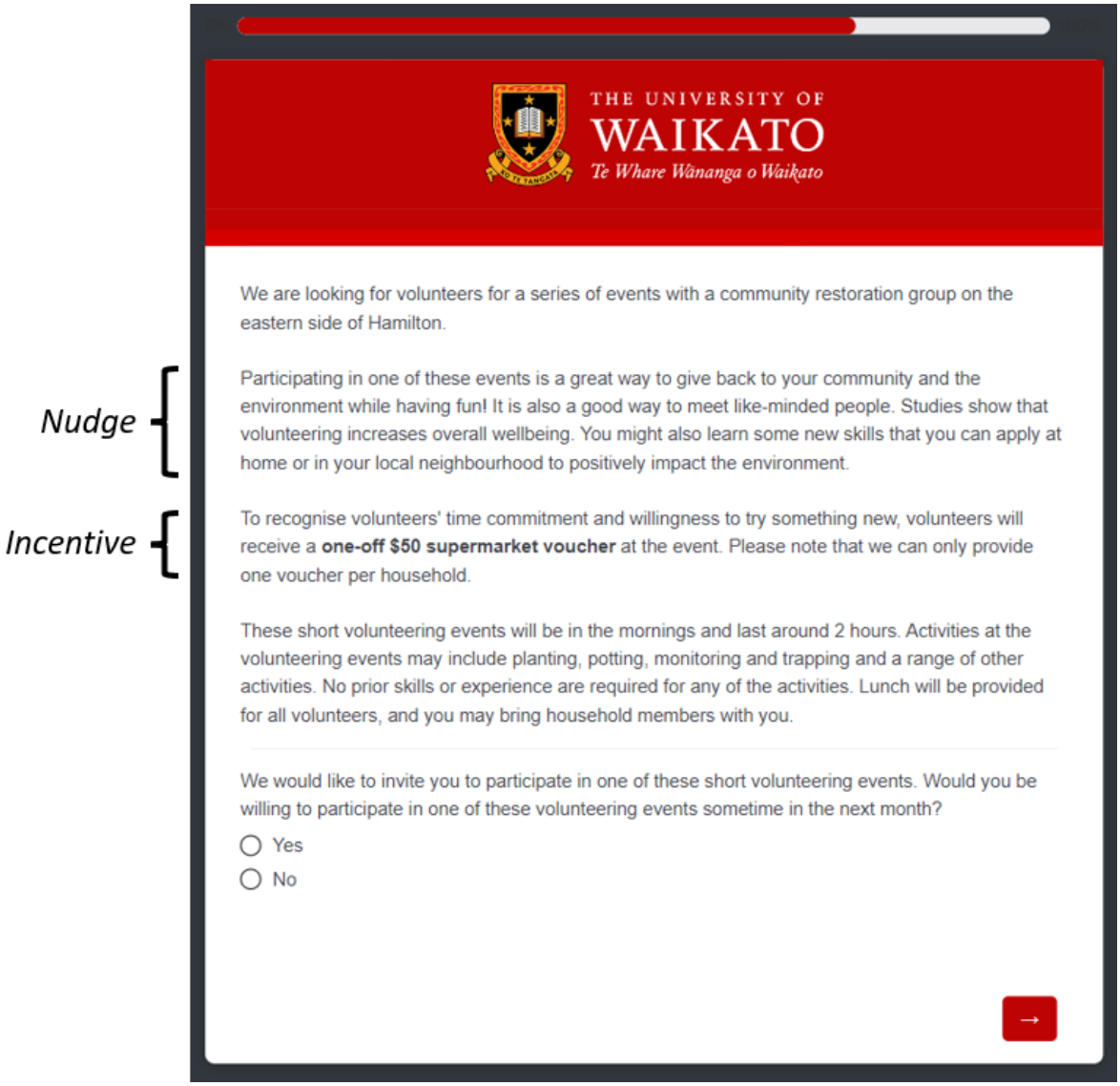

Figure 3. Question about pre-commitment for those in the combined treatment group

2.2.Volunteering Events

In conjunction with our partner the Fairfield Project, we organised four volunteering events for people to attend as part of the experimental design. The events were held over one week from the 18th to the 25th of February 2023. There were two events for the voucher-group and two other events for the non-voucher groups to choose from.

For the non-voucher groups, volunteering events were held on Saturday the 18th and Monday the 20th of February. For the voucher groups, volunteering events were held on Wednesday the 22nd and Saturday the 25th of February. The Monday event for the non-voucher group was supposed to be on Wednesday the 15th of February but adverse weather conditions the day before the event meant we re-scheduled it to Monday the 20th of February.

The events all started at 10:00 AM and concluded at 12:00 PM, where a light lunch was provided for attendees and vouchers were handed out (at the relevant events). Fortunately, all four events had similar weather conditions – fine, with a mix of sun and cloud overcast. The temperature ranged from 17ºC to 24ºC throughout the events. Volunteers could choose between several volunteering activities on the day and had two opportunities to select activities during the event. The purpose of this was to cater to a broad range of interests and skills with the hope of increasing enjoyment for those involved.

The final description of the event with full details and information was given via email after individuals committed to attending the events.

We monitored attendance at the original four events and the follow-up events using sign-in sheets from the Fairfield Project. As is standard at all Fairfield Project volunteering events, attendees needed to listen to a health and safety briefing and then sign into the site. Our research team managed these sign-in sheets at the four volunteering events, informing participants that the sheet would be used only for health and safety purposes and to track whether they attended an event as part of our research study.

2.3. Field Partnership

The Fairfield Project is an urban biodiversity and gully restoration group in Kirikiriroa | Hamilton, Aotearoa | New Zealand.[3] They have a particular focus on environmental and sustainable education for people of all ages and backgrounds. As such, they carry out educational workshops and volunteering events for schools, businesses, and the wider community.

The Fairfield project does so alongside their primary activity, the restoration, and maintenance of the ecologically significant Kukutaaruhe Gully, for which they rely on the assistance of local volunteers. They serve a diverse community in Fairfield (a suburb of Hamilton city) which includes managing several large community gardens and providing community members with opportunities to cultivate their crops. Fairfield has a central location in the small city of Hamilton, and as such it is less than a 15-minute drive from any location within the city.

The Fairfield Project has a consistent base of volunteers but is always in need of more volunteers for various tasks. Like other community nature restoration groups, we informally spoke to, the Fairfield Project find that volunteers tend to be older and that it is very difficult

[3] http://www.thefairfieldproject.co.nz/

to attract and retain new volunteers. They also expressed the concern that many local residents were unaware of the work they were doing and the opportunities to get involved as a volunteer - a sentiment shared by other community groups and shown in recent research by the Ministry for the Environment (MFE) (2021).

3. A model on motivational crowding and treatment interactions

In this section, we discuss under what circumstances a combination of two interventions would influence behaviour greater than the sum of the individual interventions in isolation. We illustrate this by adapting Bowles & Polania-Reyes's (2012) model of state-dependent preferences with intrinsic and extrinsic motivations. We add nudges to the model to better fit the context of our experiment, and explicitly allow for interactions (synergies) between nudges and incentives. Unlike Bowles & Polania-Reyes (2012), we do not model both the marginal impact of an increase in the dollar value of the incentive and the categorical effect of an incentive. Instead, we opt for a single term that captures the marginal effect of the incentive on utility and allows us to more easily and clearly model interactions between incentives and nudges. We start by setting up our basic theoretical model of intrinsic and extrinsic motivations, in line with Bowles & Polania-Reyes (2012) and then we add the effects of a nudge on behaviour and the synergies between the nudge and incentive.

3.1.Basic model with monetary incentives

Individuals can choose to what extent they want to volunteer for an environmental organisation – this is captured by a, which measures effort. Under perfect information and no uncertainty, an individual will seek to choose a level of effort a that maximises their expected utility, which is a function of the costs and benefits of contributing. Broadly, the benefits for an individual include:

- the public environmental benefits from their contribution $a\Psi$ (which is non-rival and non-excludable) and everyone else's contributions, which sum to $A\Psi$
- the monetary incentive offered s
- intrinsic rewards from volunteering v

where v includes the full range of intrinsic benefits or rewards an individual gains from volunteering. This includes the warm glow utility (Andreoni, 1990), altruism utility (intrinsic rewards from knowing you are helping people and the environment), and the intrinsic rewards from spending time outdoors interacting with others. We note that there is a distribution of

values for v across individuals. For example, some individuals may have strong environmental or social values and therefore receive significant intrinsic rewards from volunteering for nature. On the other hand, some individuals may have weak environmental and social values and receive low or no intrinsic rewards.

The utility for a specific type of individual is:

$$u = A\Psi - g(a) + as + av \tag{1}$$

As in Bowles & Polania-Reyes (2012), the contributions of the incentive and intrinsic rewards to utility increase linearly with effort a. In line with Bowles & Polania-Reyes (2012), the costs of contributing are an increasing convex function of effort $g(a)$ and the incentive is assumed to have a linear effect on utility. We then re-write the intrinsic reward component as:

$$v = \lambda_0(1 + s\lambda_m) \tag{2}$$

which captures baseline intrinsic reward λ_0 plus the potential crowding effect of the monetary incentive ($s\lambda_m$). For simplicity and illustrative purposes, the marginal effect of the incentive on intrinsic rewards is also modelled as linear. If the incentive and intrinsic rewards are independent (that is, the incentive hdoes not affectintrinsic rewards), $\lambda_m = 0$ and the intrinsic reward is equal to the baseline intrinsic reward λ_0. However, if the incentive has a negative (positive) crowding effect, λ_m will be negative (positive) and reduce (increase) the marginal utility of volunteering and contributing to the public good. Inserting equation 2 into equation 1 gives us:

$$u = A\Psi - g(a) + as + a\lambda_0(1 + s\lambda_m) \tag{3}$$

The individual maximises utility by equating the marginal cost of volunteering to the marginal benefit:

$$g'(a^*) = \Psi + s + \lambda_0(1 + s\lambda_m) \; if \; a^* > 0 \tag{4}$$

where $g'(a)$ is the first derivative of the cost function and the RHS of (4) is the marginal benefit with respect to effort a. We can see that the marginal benefit of volunteering is a function of the subsidy. If we start at $s = 0$, the effect of the incentive on the marginal benefit can be expressed as:

$$\frac{dMB}{ds} = \underbrace{1}_{Direct\ effect} + \underbrace{\lambda_0\lambda_m}_{Indirect\ effect} \tag{5}$$

Thus, there is a direct, positive effect of the subsidy, and an indirect effect ($\lambda_0\lambda_m$). Equation 5 predicts that crowding out or in is larger for those with higher baseline levels of intrinsic motivation (captured by λ_0). The intuition here underlies much of the literature on motivational crowding out – crowding out cannot occur to the same extent if an individual has little motivation to begin with. This point has been explicitly raised by other researchers too (Dorner & Lancsar, 2023).

If no crowding out effects occur, we would expect the marginal effect of the incentive on the net benefits function to be the same for those with high and low baseline intrinsic motivation (λ_0 becomes irrelevant in equation 5 when $\lambda_m = 0$).

Crowding out could occur for many reasons, as discussed in Bowles & Polania-Reyes (2012). For example, it could be that the incentive makes intrinsic rewards less salient (Chao, 2017), takes away perceived autonomy, leads to moral disengagement (Bowles & Polania-Reyes, 2012; Rode et al., 2015) or undermines the recipient's moral self-identity (Bénabou & Tirole, 2006). Incentives could also crowd in motivation (Rode et al., 2015). For example, incentives could reinforce existing environmental attitudes, signal the social desirability of a behaviour or enhance the warm glow utility effects (Rode et al., 2015).

3.2.**Adding a nudge and modelling the interaction between interventions**

Next, we incorporate the effect of a nudge on utility and behaviour. Recall that nudges alter choice architecture but do not alter economic incentives or the availability of choices (Thaler & Sunstein, 2009). Our model assumes perfect information, so the nudge cannot affect decision-making by providing information. Instead, we allow the nudge to affect utility in two ways:

1. the nudge could increase the salience of intrinsic rewards, which may give them a greater weight during decision-making.
2. the nudge could impact the crowding in (or out) effects of the monetary incentives.

The first point is the *direct effect* of the nudge, and is consistent with mechanisms around the salience of particular identities and intrinsic motivation in the nudge literature (Carlsson et al., 2021; Schubert, 2017). The second point is the indirect effect of the nudge and captures a synergy that may exist between incentives and nudges (Drews et al., 2020; Gravert & Shreedhar, 2022). For example, a nudge targeting intrinsic motivation through moral suasion (Ito et al., 2018) or social comparison (Allcott, 2011), might not only have its own direct effect

but also reduce crowding out of the monetary incentive. Clearly, incentives may also impact the efficacy of nudges, for example by undermining the intrinsic motivation channel that a nudge is targeting. Our experiment does not allow us to identify the direction in which the potential effect goes, and our model should be seen as an illustration of the interactions between the interventions.

We model the aforementioned two nudge-effects in the following way:

$$u = \Psi A - g(a) + as + a\lambda_0(1 + s\lambda_m(N) + \mathbb{1}[N > 0]\lambda_n) \quad (6)$$

The λ_n measures the categorical effect of the presence of the nudge – this is the direct effect of the nudge on intrinsic rewards. This direct effect could be positive, negative, or zero, but is most likely ≥ 0 (based on the results in the literature – see reviews by (Carlsson et al., 2021; DellaVigna & Linos, 2022; Schubert, 2017; Szaszi et al., 2022).

To incorporate the potential synergy between nudges and incentives, we assume the marginal effect of the monetary incentive on intrinsic rewards is a function of the level of the nudge. That is, λ_m is now a function of the nudge N. This means the nudge can strengthen or weaken the crowding-out/in effect of the monetary incentive. If $\lambda'_m(N) > 0$, an increase in the nudge would strengthen the crowding-in and weaken the crowding out.

Like before, utility maximisation means equating the marginal cost of volunteering to the marginal benefit:

$$g'(a^*) = \Psi + s + \lambda_0(1 + s\lambda_m(N) + \mathbb{1}[N > 0]\lambda_n) \; if \; a^* > 0 \quad (7)$$

Again, if we start at $s = 0$, the effect of the monetary incentive on the marginal benefit can be expressed as:

$$\frac{dMB}{ds} = \underbrace{1}_{Direct\ effect} + \underbrace{\lambda_0\lambda_m}_{Indirect\ effect}(N) \quad (8)$$

The indirect crowding-out/in effect of the incentive now depends on the level of the nudge. If $\lambda'_m(N) > 0$ then the nudge will strengthen a crowding-in ($\lambda_m > 0$) of the subsidy, and it will weaken a crowding-out ($\lambda_m < 0$) of the subsidy. This also has implications for the comparison of the combination of two instruments with the sum of the individual effects. To begin with, if $\lambda'_m(N) = 0$, then the combined effect on marginal benefit is the same as the sum of the individual effects. Following equation (7), due to the convexity of $g(a)$, the observed effect on a will be less than the sum of separate effects of the subsidy and nudge. If there is motivation

crowding out of the monetary incentive ($\lambda_m(N) < 0$), and if the nudge weakens the crowding out ($\lambda'_m(N) > 0$), then we expect the combined effect to be at least as large as the sum of the individual effects. Again, to what extent the combined effects is larger depends on the convexity of the cost function.

Moreover, the expression in (8) suggests that the potential crowding out, and the corresponding offsetting effect of the nudge, depends on the baseline intrinsic reward. If we assume that λ_m is negative (crowding out occurs), we can consider the opposite cases where $\lambda_0 = 0$ and $\lambda_0 = 1$. Where baseline intrinsic motivation is very low ($\lambda_0 = 0$), the incentive will have a standardised impact of 1. However, when baseline intrinsic motivation is high ($\lambda_0 = 1$), the incentive will have an impact of $1 - \lambda_0\lambda_m$. Depending on the size of the crowding out effect λ_m, the standardised impact of the incentive would be zero or even negative. This also means that if the nudge weakens the crowding out effect of the monetary incentive (($\lambda'_m(N) > 0$), it would only do so for those with a high intrinsic reward ($\lambda_0 = 1$), and have no effect for those with a low intrinsic reward ($\lambda_0 = 0$).

4. Hypotheses and empirical methods

Following from our theoretical model, we test the following hypotheses:

H1 **All three treatments will increase the likelihood of volunteering (relative to the control).**

This assumes that $\lambda_n > 0$ (the nudge impacts the net benefits function and shifts behaviour), $\frac{dMB}{ds} > 0$ (the incentive's overall marginal impact is positive), and that the combination of the nudge and voucher has a positive impact on the utility function. Previous literature suggests that the monetary incentive may have a crowding out effect on intrinsic motivation. However, within the context of this experiment, we chose a monetary incentive that *a priori* we expect to more than compensate for any crowding out effects (Gneezy & Rustichini, 2000).

H2a **There will be an interaction (synergy) between the nudge and incentive such that the combined treatment effect is at least as large as the sum of the individual treatment effects.**

Thus, we hypothesize that there is a potential positive synergy effect. Based on our model, if we observe the sum of the individual treatment effects being the same as their individual

effects, this may still show a positive synergy due to the convex cost of effort function. If we see the sum is greater than the individual effects, then there is unambiguously a positive synergy. *A priori,* we expect a positive synergy to occur due to motivational crowding out from the monetary incentive, and the nudge reducing this crowding, giving us our next hypothesis.

H2b The positive synergy between the nudge and incentive is driven by changes in motivational crowding effects arising from the incentive.

To test our first two hypotheses (H1 and H2a) on treatment effectiveness, we conduct a series of hypothesis tests with predominantly non-parametric chi-squared hypothesis tests in line with our pre-registration and will recover the causal effect of our randomly assigned treatments on our outcomes of interest. Of course, these tests rely on the assumption that treatment assignment is exogenous, which we verify with balance checks in the data section.

Hypotheses 2b implies that we would expect to observe crowding out of motivation amongst the highly motivated in the voucher condition and less crowding out amongst the highly motivated when the nudge is also used (the combined treatment condition), as illustrated by our model (Dorner & Lancsar, 2023). To test this, we will condition the treatment effect by the level of intrinsic motivation. We will use a construct of environmental self-identity as an approximation for our underlying environmental motivation latent variable. To explore the synergy mechanism, we include interaction terms between environmental identity and treatment status in regressions explaining commitment and actual attendance.[4]

We estimate linear probability models to predict the probability of committing to volunteering and the probability of donating.[5] All models are run with Huber-White robust standard errors. We create a new binary variable to distinguish between those with high and low environmental identity (EID). An individual with an EID score of less than five is considered to have a relatively low EID (noting that our sample has higher than average EID as environmentally conscious individuals are more likely to be pre-screened into the sample of potential first-time nature volunteers). We choose less than five because that would suggest the individual is saying they less than somewhat agree on average that being environmentally friendly is important to

[4] Our main focus is on the commitment stage because the decision to actually attend is a function of a number of random elements beyond our control, such as availability the particular date. Furthermore, attendance is conditional on commitment, which means that the actual decision to attend or not is largely driven by the commitment decision.

[5] The results are very similar when using logistic regression and computing average marginal effects post-estimation; results are available upon request from the authors.

them. We denote the remaining group (with EID > 5.0) as having a high EID. Hence, the basic model we estimate is:

$$Y_i = \beta_0 + \beta_1 Nudge_i + \beta_2 Voucher_i + \beta_3 Combined_i + \beta_4 EID_i + \beta_5 (Nudge * EID)_i + \beta_6 (Voucher * EID)_i + \beta_7 (Combined * EID)_i + \varepsilon_i$$

where Y_i is a indicator variable of committing to volunteer, the β terms are the coefficients on each term in the regression, $Nudge_i$, $Voucher_i$ and $Combined_i$ are indicator variables for if individual i is a member of that treatment group, EID_i is a binary variable indicating if individual i has high EID and ε_i is the idiosyncratic error term.

In order to investigate if there is motivational crowding and synergy effects, we compare the interaction terms across the treatments. If there is motivational crowding out of the monetary incentive, and if the direct effect of the monetary incentive is independent of the level of EID, then we expect β_6 to be negative, i.e., the effect of the incentive is smaller for those with a high EID. If the nudge reduces the motivational crowding out of the incentive, then we expect β_7 to be statistically insignificant, or even positive.

5. Data

The data we use are from several sources, including our online survey (this is the main source of data), the commitment survey and attendance sheets from the volunteering events (see section 2). Survey one received high engagement and we ended up with a total usable sample of N = 757 (this includes those who are already volunteering). We excluded individuals who were strongly opposed to volunteering, under 18 years of age, were not the first household member to complete our survey, and did not live near Hamilton. We also dropped responses that were less than 75% complete. Of the 757 respondents, 130 were already volunteering for nature restoration groups and 627 were classified as "first-time" volunteers (did not volunteer for a nature restoration group over the last three years). This sample of first-time volunteers (N = 627) is our sample of interest.

5.1.Demographics

We collected data on a range of demographics. Table 1 reports the demographic summary statistics for our overall sample. This includes those already volunteering and not part of our treatment intervention. We note that our sample is not meant to be representative of the New

Zealand population. Rather, our sample is aimed at being representative of those living near an urban centre with at least a minor interest in volunteering for a restoration group.

Our sample is highly female-dominated and tends to be well-educated, with 58% of respondents having attained at least a bachelor's level education (this is higher than the overall population - Ministry of Social Development, 2016). In terms of ethnicity, approximately 24.5% of New Zealand residents identify as either Māori or Pacific, aligning closely with our data (23% Māori or Pacific). Most respondents never or infrequently volunteer elsewhere. Those already volunteering are more likely to be male, less likely to be Māori or Pacific, more likely to live outside of Hamilton City, and are less likely to have a dependent child. Those already volunteering have higher EID scores and our EID index variable has a Cronbach's alpha of 0.90, indicating strong internal consistency (Cortina, 1993; Cronbach, 1951).

Table 1. Demographics summary statistics

	Full sample (N = 757)	First-time volunteers (N = 627)	Already volunteering (N = 130)
Variable	Mean	Mean	Mean
Age	43 (16)	43 (16)	45 (16)
Māori and Pacific Ethnicity	23%	24%	16%
Bachelor or higher	58%	56%	66%
Income (perceived)			
Low	24%	25%	18%
Middle	63%	63%	65%
High	12%	12%	16%
Gender			
Female	71%	74%	56%
Male	28%	26%	40%
Gender diverse	1%	1%	4%
Employment status			
Full time	50%	50%	50%
Student	7%	7%	6%
Retired	11%	11%	12%
Part-time	16%	15%	17%
Other employment	18%	18%	16%
Geographic location			
Resides outside Hamilton City	16%	15%	24%
Resides near Fairfield	17%	17%	15%
Children			
Has a child	35%	36%	30%
Has a child under 14 years	29%	30%	23%
Other volunteering behaviour			
Never volunteers elsewhere	38%	41%	24%
Infrequently volunteers elsewhere	41%	39%	52%
Sometimes volunteers elsewhere	11%	11%	10%
Frequently volunteers elsewhere	10%	9%	15%
EID			
EID scale	5.6 (0.9)	5.5 (0.9)	5.9 (0.9)

Note: Standard deviation in parentheses for continuous variables.

Our environmental identity (EID) index measures beliefs about how environmentally friendly one is. Environmental identity has been widely studied in psychology and has strong associations with pro-environmental behaviour (Sparks et al., 2021; Whitmarsh & O'Neill, 2010).. We deploy the widely used environmental self-identity scale (EID) from van der Werff et al. (2013). This is a three-item scale that is replicated exactly for our surveys.

For those who pre-committed to attend a volunteering event over the following month, we also gathered information on their general availability to attend events. Immediately following pre-

commitment, we asked individuals to select any dates over the upcoming four weeks (from an on-screen calendar) where they were likely to be available to attend a volunteering event between the hours of 10:00 AM and 12:00 PM. This gave us a count variable for the number of days each pre-committed individual was available (taking values between 0 and 28), providing us with a measure of availability.[6]

5.2.Balance Test

In Table 2, we report demographic summary statistics for each treatment group and observe a good balance overall. Moreover, we formally assess whether randomisation was successful using a multinomial logit model to predict treatment status. We include all of our demographic control variables (16 coefficients in total) and the results are reported in the Appendix. Of the 48 estimated coefficients, only five are significant at the 10% level, which is what we would expect to see by chance alone. With any conservative corrections for multiple hypothesis testing, we find no significant coefficients. This indicates that our demographics have no true predictive power over treatment assignment.

We confirm this by estimating a second multinomial logit model with intercepts only (no regressors or explanatory variables). We find that the Akaike Information Criteria (AIC) is lower (indicating a better model fit) for the model with no variables (1,742.7) than the model with our full set of controls (1,779.8). This is also shown in the Appendix. Finally, an LR test comparing the complete and empty models reveals that the covariates jointly are non-significant in predicting treatment status (p-value of 0.136).

We can conclude that our treatments were successfully randomly assigned and proceed to our chi-squared hypothesis testing and regression results.

[6] Some respondents (N~10) accidentally skipped forwards and could not return to the calendar. However, in general, these individuals informed us of this and told us qualitatively which days they would be available. Hence, we manually coded availability for these individuals. If they told us they skipped forwards by mistake and did not indicate their availability, we assigned them the median value.
It is also worth noting that we capped the variable at 28 days (because we asked about the following four weeks).

Table 2. Demographic summary statistics by treatment group.

Variable	Control (N = 145)	Nudge (N = 154)	Voucher (N = 161)	Combined (N = 167)
Age	44	43	40	42
Māori and Pacific Ethnicity	22%	25%	27%	22%
Bachelor's or higher	57%	60%	58%	51%
Income (perceived)				
Low income	26%	16%	30%	29%
Middle income	62%	66%	63%	61%
High income	12%	18%	7%	10%
Gender				
Female	72%	70%	76%	75%
Male	27%	28%	24%	24%
Gender diverse	1%	2%	0%	1%
Employment status				
Full time	54%	52%	44%	50%
Student	3%	5%	13%	6%
Retired	10%	10%	9%	13%
Part time	15%	17%	17%	12%
Other employment	18%	16%	18%	19%
Geographic location				
Resides outside Hamilton City	14%	18%	12%	14%
Resides near Fairfield	19%	14%	17%	19%
Children				
Has a child	39%	32%	42%	33%
Has a child under 14 years	32%	25%	34%	28%
Other volunteering behaviour				
Never volunteers elsewhere	41%	45%	37%	40%
Infrequently volunteers elsewhere	37%	36%	43%	41%
Sometimes volunteers elsewhere	14%	9%	11%	12%
Frequently volunteers elsewhere	8%	10%	9%	7%

Note: We do not report standard deviations for brevity and because the standard deviation for proportions can be readily calculated using the values in the table.

6. Results

6.1. Overall treatment effects on volunteering

In Figure 4 we present a summary of the volunteering rates by treatment groups.

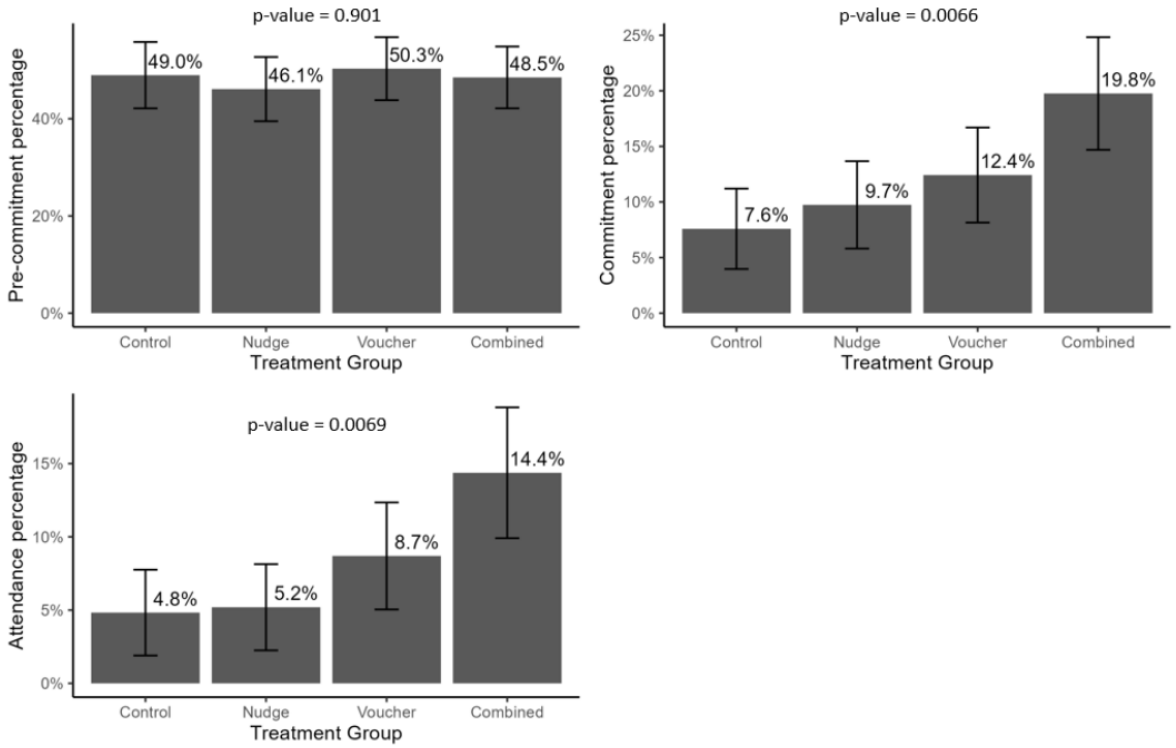

Figure 4. Summary graph of volunteering rates by treatment group. Error bars show 90% confidence intervals. Pre-commitment is in the top left, commitment is in the top right, and attendance is in the bottom left. The p-values are from chi-squared tests for differences between the groups.

As expected, volunteering rates are highest at the pre-commitment stage. They are drastically reduced at the commitment stage, and then falls a bit more at the attendance stage. At the pre-commitment stage there are no sizeable differences between treatment groups. For the two other stages, the volunteering rate is highest for the combined treatment, followed by the voucher treatment.

We also note that there is a non-negligible group of people willing to volunteer for the first time in the control condition. This suggests that the provision of information and being asked directly to volunteer has a positive impact on volunteering rates, and we know this because our sample only includes those who are not already engaged in nature volunteering. Hence, our treatment comparisons to the control should be interpreted as relative to the provision of basic information about a volunteering opportunity.

6.2. Treatment effects

Our first hypothesis (H1) concerns the effect of the various treatments on volunteering rates, relative to the control. In Table 3, we report the pairwise average treatment effects and p-values

from our set of pre-registered one-sided chi-squared tests. We find that there are no statistically significant differences between the nudge treatment and the control group for any outcome. On the other hand, there are statistically significant differences in commitment and attendance rates between the voucher treatment and control (significant at the 10% level) and the combined treatment and control (significant at the 1% level).

Table 3. Average treatment effects (ATE)

	Nudge v Control		Voucher v Control		Combined v Control	
Pairwise comparisons	ATE	p-value	ATE	p-value	ATE	p-value
Pre-commitment	-2.9%	0.690	1.3%	0.407	-0.5%	0.533
Commitment	2.1%	0.254	4.8%*	0.081	12.2%***	0.0010
Attendance	0.4%	0.442	3.9%*	0.091	9.6%***	0.0025

*Note: These are one-sided chi-squared tests in line with our hypotheses and pre-registration. * p < 0.10, ** p < 0.05, *** p < 0.01.*

The first hypothesis is thus only partially supported. Our results show the voucher and combined treatments increase the probability of committing to and attending a volunteering event. However, the nudge alone is ineffective at increasing volunteering. We also find that none of the treatments affect pre-commitment to volunteer,

Our second hypothesis (H2a) concerns the comparison between the combined treatment effect and the individual nudge and voucher treatment effects. Firstly, in Table 4 we compare willingness to volunteer in the combined treatment group with those in the nudge group and voucher groups separately. We find that the combined treatment is more effective than both the nudge and voucher alone at promoting commitment to and attendance at volunteering events. For example, the average treatment effect (ATE) of the voucher on commitment is a 4.8% increase and when the voucher is combined with the nudge, the ATE is 12.2%.

Table 4. Results for combined vs individual treatment effects on volunteering behaviour.

	ATE for the treatment group			*Comb v Nudge*		*Comb v Voucher*	
Variable	Nudge	Voucher	Combined	χ^2	p-value	χ^2	p-value
Pre-commitment	-2.90%	1.30%	-0.50%	0.18	0.334	0.11	0.628
Commitment	2.10%	4.80%	12.20%	6.32***	0.006	3.258**	0.035
Attendance	0.40%	3.90%	9.60%	7.52***	0.0031***	2.58*	0.0542

*Note: These are one-sided chi-squared proportion tests in line with our pre-registered hypotheses. ATEs are relative to the proportion committing (for example) in the control group. Sample sizes are N = 154 for the nudge group, N = 161 for the voucher group and N = 167 for the combined group. * p < 0.10, ** p < 0.05, *** p < 0.01.*

In order to test if the combined treatment effect is larger than the sum of the two individual treatment effects, we calculate an upper bound on the treatment effect under no synergy (simply the sum of the two individual treatment effects) and compare this to the treatment effect we observe for the combined group. Simply adding the nudge and voucher treatment effects gives an upper bound on no synergy because of the convex nature of the cost of effort function (we would expect diminishing returns to intervention, so the linear addition will likely overestimate the true effect on effort under no synergy). We show these results in Table 5. For example, for the effects of the treatments on commitment, our upper bound treatment effect estimate under no synergy is 6.9% but we see a treatment effect almost double in size (12.2%). These differences are statistically significant under basic one-sided and two-sided tests. This shows that there are likely positive synergies between the nudge and incentive because their combined effect is much greater than the sum of the individual effects.

Table 5. Comparison of the actual ATE and the expected ATE under no synergy for the combined treatment group.

	Expected	Actual	Actual – Exp	Two-sided	One-sided
Pre-commitment	-1.60%	-0.50%	1.10%	0.295	0.148
Commitment	6.90%	12.20%	5.30%	0.021**	0.011**
Attendance	4.30%	9.60%	5.30%	0.050**	0.025**
N	315	167	482	-	-

*Note: These are simple two-proportion Z tests comparing the expected ATE under no positive synergy and the actual ATE. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.*

Thus, our results support our second hypothesis that the combined treatment is significantly more effective than either the voucher treatment or the nudge treatment alone. Moreover, we show that the combined treatment effect is greater than the sum of the individual treatment effects from the nudge and the incentive. This shows there are positive synergies between nudges and incentives in this context.

6.3. Exploring the mechanism behind the interaction effect between nudge and voucher

In this section of the results, we explore the mechanisms behind the positive synergy between the nudge and the voucher. As discussed, our model suggests that crowding in and out mechanisms will be exhibited more strongly in those with high EID than those with low. The regression models results are presented in Table 6. As a reminder, if the incentive crowds out some intrinsic motivation, we would expect the coefficient on the interaction between EID and the voucher to be negative (because crowding out will be greater at high EID). Likewise, if the

nudge reduces crowding out, we would expect the interaction between EID and the combined treatment to be less negative (and perhaps even positive).

There are a couple of points to be aware of. Firstly, the pre-commitment results are included for completeness as one of the short-run outcome variables. However, as discussed earlier, none of the treatments had any statistically significant impact on pre-commitment compared with the control and our results below show this is true for those with high and low environmental identity. The second thing to note is that we include availability as a control variable in the commitment model. This is because general availability is a highly important predictor of commitment because availability constrains an individual's ability to commit to a specific event. This control is only relevant for the commitment model where respondents are required to commit to a specific set of dates. Third, attendance is only possible if a subject has committed to attend, and attendance is also probably subject to random elements such as availability on that actual date. Our focus is thus on the commitment stage.

At the commitment stage, both the voucher and combined treatment are effective at encouraging those with low EID to commit to volunteering.

On average, the voucher increases commitment probability by 18.5% and the combined treatment increases it by 15.3%. However, in the voucher treatment, the interaction term with EID is negative and statistically significant, and the total marginal effects for those with a high EID is near zero: 1.3%. This suggests that there is motivational crowding out from the incentive among those with a high EID. On the other hand, for the combined treatment, the interaction term is not statistically significant and is close to zero, which means that the combined treatment is just as effective for those with high EID and those with low EID. Contrasting this with the voucher treatment, this suggests that the nudge reduces the motivational crowding out of the monetary incentive.

An alternative mechanism could be that the incentive is increasing the effectiveness of the nudge. In general, there is little empirical work to support such speculation, but it could be that there is some utility threshold at which people start paying attention to the nudge. That would imply that some people start paying attention to the nudge only when it is coupled with a utility-increasing incentive. If this were the case, we would expect the nudge treatment to be more effective (or less ineffective) amongst those with high environmental identity. This is because those with high EID are more likely to be sufficiently motivated to pay attention to the nudge in the first instance, as they have greater expected utility from volunteering. However, we do

not see this borne out in the results. Indeed, the nudge is equally as ineffective for both those with high and low EID.

Table 6. Regression results for treatment-EID interactions

	Pre-commitment	Commitment	Attendance
Nudge	0.004	0.013	-0.012
	(0.111)	(0.030)	(0.024)
Voucher	0.135	0.185***	0.064
	(0.120)	(0.064)	(0.043)
Combined	0.169	0.153***	0.152***
	(0.119)	(0.058)	(0.058)
Moderate to High EID	0.283***	0.079***	0.046*
	(0.096)	(0.030)	(0.024)
Availability		0.023***	0.021***
		(0.004)	(0.004)
Nudge*High EID	-0.020	0.009	0.016
	(0.128)	(0.049)	(0.038)
Voucher*High EID	-0.146	-0.172**	-0.032
	(0.136)	(0.074)	(0.053)
Combined*High EID	-0.212	-0.029	-0.063
	(0.135)	(0.071)	(0.067)
Intercept	0.259***	-0.035**	-0.032**
	(0.084)	(0.017)	(0.016)
Observations	627	627	627
R^2	0.029	0.116	0.127
Adjusted R^2	0.018	0.105	0.115

*Note: Robust standard errors in parentheses. p < 0.10, ** p < 0.05, *** p < 0.01.*

7. Conclusions

In this paper, we add to the growing literature on the effects and synergies of combining nudges and incentives (Dorner, 2023; Drews et al., 2020; Gravert & Shreedhar, 2022). This is an under-researched area of the literature where there are mixed results and important policy implications (Drews et al., 2020). We also add to the very limited experimental literature on interventions to encourage PEBs that relate specifically to nature and biodiversity (in our case, nature restoration volunteering). This is important now more than ever, as we are rapidly diminishing the natural environment and the ecosystem services that global communities critically depend upon (Costanza et al., 2017). Across the behaviour change literature, there has been a lack of focus on the behaviours that matter most for the end outcomes of interest (in our case, environmental outcomes - Al-Ubaydli, List, & Suskind, 2017; Grilli & Curtis, 2021; Nielsen et al., 2021). More often than not, studies focus on behaviours that are easy to measure and monitor, which has meant an abundance of research relating to some behaviours (like water and energy consumption) and a shortage of research on others (Brent et al., 2017).

We find that offering a one-off financial incentive significantly increases nature restoration volunteering behaviour. Despite concerns that financial incentives may crowd out intrinsic motivation (particularly for behaviours with high intrinsic motivation components, like volunteering), we find that on balance financial incentives increase short-term nature restoration volunteering. Next, we find that nudging participants alone does not affect first time volunteering behaviour compared with providing basic information about the volunteering opportunity. This adds to the growing number of review studies that find that nudge effects can be very small (and often zero) in many contexts (Szaszi et al., 2022). However, there are considerable *positive* synergies between the nudge and voucher incentive, with the voucher effectiveness being significantly enhanced when coupled with a nudge. For policymakers, this suggests that the efficacy of incentive-based interventions to encourage the uptake of nature restoration volunteering (and potentially other behaviors) could be enhanced by coupling the intervention with a low-cost nudge. We also find support for the prediction that the positive synergies are caused by the nudge reducing any motivational crowding out arising from the incentive. This further reinforces the recommendation to use nudges alongside incentives as they may reduce the crowding out effects policymakers are traditionally concerned about.

These results add to recent literature that examines the presence of synergies between nudges and financial incentives (Drews et al., 2020; Fanghella et al., 2021; Sloot & Scheibehenne, 2022). Most studies focus on energy consumption as the behaviour of choice, and we are the first to study this synergy (as far as we are aware) in the context of nature restoration volunteering. This is pertinent because synergies can be positive, negative and null, depending on the context, and policymakers need more empirical evidence to evaluate possible synergies in different contexts. Some studies show negative synergies (nudges distract participants from incentives and vice versa) so it is important to assess synergies empirically before coupling nudges and incentives in large-scale interventions (Drews et al., 2020; Fanghella et al., 2021). We note that there are only a few studies that can test for these synergies, so more work is needed in this space (Drews et al., 2020).

In addition, we only deployed one variation of the financial incentive (in terms of value and the framing of the incentive). We designed our incentive to limit crowding out of intrinsic motivation by emphasising the one-off nature of the incentive and that it was to help people try volunteering for the first-time. Our results are found in the context of this specific incentive design, and we cannot say what role the framing, value of the incentive, or context (volunteering for nature restoration) had on our results. The literature on the crowding effects

of financial incentives is mixed and future research could consider deploying different values of incentives and using different framings to evaluate crowding-in or out potential in the context of nature restoration volunteering.

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