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# Greening Household Behaviour: Cross-domain Comparisons in Environmental Attitudes and Behaviours Using Spatial Effects

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# ENVIRONMENT WORKING PAPER No. 68 - GREENING HOUSEHOLD BEHAVIOUR: CROSS-DOMAIN COMPARISONS IN ENVIRONMENTAL ATTITUDES AND BEHAVIOURS USING SPATIAL EFFECTS

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*Keywords: environmental attitudes, civic engagement, household surveys, behavioural economics, GIS*

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## ABSTRACT

Discussions of the importance of public attitudes in shaping policy often lack clear evidence on causal relations between stated attitudes and observed behaviours. The 2011 OECD Survey of over 12,000 households allows analysing households' environmental attitudes and behaviours in five different domains (electricity, food, transport, waste and water). Using econometric analysis, we investigate the relationship between stated environmental attitudes and indicators of civic engagement, such as voting in local elections, charity membership and membership in environmental organisations.

The analysis probes whether civic engagement shapes environmental attitudes or whether attitudes determine levels of civic engagement (or both). To understand environmental activism, a spatial perspective is adopted, as households in the same neighbourhoods and communities may be more likely to have similar attitudes and behaviours. From a policy perspective, knowing the extent of attitudinal clustering over space can help identify how policies may be targeted at the community and regional-level.

Greater levels of civic engagement appear to lead, surprisingly, to more sceptical attitudes about environmental claims and issues. Yet at the same time, those less sceptical about the importance of environmental problems are *a priori* more predisposed to engaging in their communities, including in particular becoming involved in environmental organizations. In terms of policy implications, involvement in environmental organizations is best understood as a revealing indicator of attitudes, rather than a lever by which the government can affect behaviour.

These results are then applied to examine how environmental attitudes mediate the effects of policy measures. To this end, the interacting effects of incentive-based policies and attitudes are jointly examined across three domains: energy conservation, water conservation and waste prevention. Attitudes are found to comprise an important factor mediating the effects of all incentive-based policies analysed, but the pattern of this mediation is not uniform across domains. For example, time-of-use electricity pricing and unit-based water pricing policies are found to achieve the bulk of their measured behavioural response among inherently motivated individuals. In contrast, environmental sceptics are more responsive to pay-as-you throw waste collection charges.


**JEL Classification:** D12, Q58, D10, D64, D71, H89, Q50, C51, D11.

**Keywords:** environmental attitudes, civic engagement, household surveys, behavioural economics, GIS.

## RESUME

La réflexion sur le rôle des attitudes du public dans l'élaboration des politiques manque souvent d'éléments probants au sujet du lien de causalité existant entre les attitudes déclarées et les comportements observés. L'enquête réalisée par l'OCDE en 2011 auprès de plus de 12 000 ménages permet d'analyser leurs attitudes et comportements environnementaux dans cinq domaines distincts (électricité, alimentation, transports, déchets et eau). Sur la base d'une analyse économétrique, on étudie ce qui lie les attitudes environnementales déclarées à différentes formes d'engagement civique, telles que voter aux élections locales, s'impliquer au sein d'une œuvre caritative et être membre d'une association de défense de l'environnement.

On vérifie si le niveau d'engagement civique détermine les attitudes environnementales ou s'il en dépend (ou les deux). Pour mieux cerner le militantisme écologique, on se place du point de vue spatial car il est plus probable que les ménages d'un même quartier ou d'une même communauté présentent des points communs en termes d'attitudes et de comportements. Du point de vue de l'action publique, la connaissance du regroupement spatial des attitudes peut aider à trouver un moyen de mieux cibler les mesures engagées sur le plan local et régional.

On constate avec surprise qu'un plus grand engagement civique se traduit par un scepticisme accru à l'égard des allégations et questions environnementales. À l'inverse, ceux qui doutent moins de la gravité des problèmes environnementaux sont a priori plus enclins à s'engager à l'échelle locale, notamment en s'impliquant auprès d'associations de défense de l'environnement. Pour les pouvoirs publics, un tel engagement constitue un indicateur probant d'attitudes et non un levier à actionner pour modifier les comportements.

Ces résultats servent ensuite à étudier la manière dont les attitudes interviennent dans les effets des mesures engagées par les pouvoirs publics. À cette fin, on examine conjointement les effets d'interaction des moyens d'action fondés sur l'incitation et les attitudes dans trois domaines : les économies d'énergie, les économies d'eau et la prévention des déchets. Il apparaît que les attitudes constituent un facteur de premier plan dans les effets de tous les moyens d'action fondés sur l'incitation auxquels on s'intéresse, mais de manière hétérogène selon les domaines. On constate par exemple que la tarification horosaisonnière de l'électricité et la tarification unitaire de la consommation d'eau modifient essentiellement le comportement des individus intrinsèquement motivés. En revanche, les « enviro-sceptiques » sont plus réceptifs à une tarification incitative de la collecte des déchets.

**Classification JEL** : D12, Q58, D10, D64, D71, H89, Q50, C51, D11.

**Mots-clés** : attitudes envers l'environnement, engagement civique, enquête ménages, économie comportementale, SIG.

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## INTRODUCTION

Environmental challenges and the policies introduced to address them do not arise in a vacuum. They compete for the public's attention with a host of other demands, including economic concerns, social issues, as well as other environmental problems. This milieu affects the feasibility of implementing different policies, and determines how well these policies address their focal issues. The social and economic context also determines secondary impacts in other domains of environmental policy.

As shown in the publication providing an overview from the 2011 OECD survey on Environmental Policy and Individual Behaviour Change (EPIC),[1] trust in government is a major factor determining the relative importance that individuals attribute to the claims made by governments about environmental issues. For example, trust is a more powerful factor than levels of university schooling in predicting whether people believe climate change is anthropogenic.[2] The survey results also point to a significant – if complex – relationship between expressed levels of environmental concern and pro-environmental actions taken by households. Those expressing high levels of environmental concern tend to take more action (though often small in scale) to benefit the environment, especially in the areas of energy/water efficiency and waste prevention, than their less-concerned counterparts.

Yet from the perspective of policy analysis, the question arises how one can meaningfully apply such results? Answering this question requires a deeper understanding of attitude formation, the impacts of these attitudes on observed behaviours across multiple domain policy domains (e.g. energy conservation, waste prevention, etc.). A complex set of factors underpins environmental awareness, ranging from knowledge, the availability of information – and indeed trust – to social factors such as the concerns of neighbours and levels of environmental activism and awareness within one's community. Knowing the determinants of environmental awareness can in turn help predict how such awareness, and consequent levels of support for environmental policy, might change in response to the 'social marketing' campaigns that often accompany consumer-oriented environmental policies.

In addition, better understanding these determinants can isolate the specific core of certain attitudes that translates into desirable action. For example, OECD (2014) finds that membership in an environmental organization predicts a range of pro-environmental behaviours – in particular, action to improve energy efficiency. However, one might naively conclude from this finding that directly increasing membership in such organizations (e.g. through incentives, or subsidization of such groups)[3] might therefore translate into greater concern for the environment, and greater pro-environmental action at home. Such a conclusion ignores the likelihood that those with already high levels of environmental concern are the ones most likely to join such organizations. The more likely case is that there is some degree of both effects: those more concerned about environmental problems are more likely to join to such organizations, but at the same time probably acquire greater awareness through participation. The relative size of each effect is one topic analysed in this paper.

[1] OECD (2014). The results of the first EPIC survey implemented in 2008 in ten OECD countries are presented in OECD (2011).

[2] Chapter 2 in OECD (2014).

[3] One obvious way in which public authorities encourage membership is through tax deductions for financial contributions toward membership.

To understand environmental activism and awareness, it is useful to adopt a spatial perspective, because households in the same neighbourhoods and communities may be more likely to have similar attitudes and behavioural patterns. A number of feedbacks may give rise to such spatial correlations and "clustering." Clearly, there is some sorting in residential location choices: households want to live near similar households. At the same time, people may adopt similar viewpoints as their neighbours and peers after living in a location for a period of time. This arises because people acquire a deeper understanding of different points of view (e.g. through interacting with their neighbours) or because of exposure to different institutional and governance systems. For example previous work with the 2011 EPIC data shows that the public's attitudes towards incentive-based environmental policies may increase as citizens acquire more experience and familiarity with such policies.[4]

Although cross-sectional survey data of the type analysed here cannot fully tease out the relative magnitude of these feedbacks, a useful first step is to understand the structure of this attitudinal clustering over space, and to subsequently probe the causal explanations for the observed patterns. From a policy perspective, knowing the extent of such clustering can help identify how policies may be targeted at the community and regional-level. In particular, when environmental awareness is highly clustered (as opposed to evenly and randomly diffused across neighbourhoods), then government environmental awareness campaigns may save money by prioritising efforts first on those regions with lower levels of awareness.

In analysing the determinants of attitude formation, this paper focuses in particular on this spatial clustering issue. To measure the feedback between community-level factors and individuals' attitudes, the paper examines, first, whether individuals' attitudes appear to affect different types of community engagement activities, such as voting in local elections or joining various types of volunteer groups. The paper also investigates the role of neighbours' levels of community engagement in affecting an individual's own levels of engagement. Subsequently, the analysis investigates the extent to which community engagement transforms individuals' own attitudes specifically about environmental issues.

The basic results yielded from the analysis suggest that individuals are more likely to engage in different community activities if they have an attitudinal predisposition matching that activity, e.g. environmentally motivated individuals are more likely to join an environmental organization. But neighbourhood-level engagement also appears to affect individuals' propensity to engage, which provides the possibility for an econometric examination of the other direction of causality: whether and how engagement shapes environmental attitudes. Here the analysis implies that greater aggregate levels of civic engagement appear to lead, surprisingly, to more sceptical attitudes about environmental claims and issues. The overall implication from these econometric results is that civic engagement – in particular, membership in environmental organizations – can serve as a useful proxy for revealing an individual's pre-existing attitudes towards environmental problems, but such engagement does not necessarily lead to greater pro-environmental attitudes and in fact can sometimes lead to greater scepticism about environmental issues, particularly relative to other policy issues such as social and economic concerns.

Of course, the broad objective of household environmental policies is to positively affect behaviour. In this regard, it is instrumental to better understand how environmental attitudes interact with policies. While other technical papers using econometric techniques to analyse the dataset go into great detail within the five specific thematic domains,[5] an advantage of the EPIC survey data is to permit analysis of how the same individuals behave across domains. This permits us to examine, first, whether similar policies have similar impacts across domains, and subsequently whether attitudes mediate the effects of similar policies

[4] Brown and Johnstone (2014).

[5] See OECD (2014).

in the same ways across domains. For example, do unit-based pricing policies for water provision and solid waste collection achieve different behavioural responses across attitudinal groups (e.g. environmentally motivated compared to environmental sceptics), and how can observed differences be explained? Some potential reasons for this finding are identified.

The analysis in this paper illustrates that, while incentive-based policies appear effective in yielding behavioural responses across domains, these policies can differ in terms of which attitudinal group appears to generate the majority of the response. For example, time-of-use electricity pricing and unit-based water pricing policies are found to achieve the bulk of their measured behavioural response among households with environmentally motivated worldviews, whereas PAYT charges for waste collection – in contrast – achieve the majority of their impact by affecting the behaviours of environmentally sceptical individuals.

Cross-domain analysis of policy impacts can also shed light on attitudinal and psychological foundations for such behaviours that transcend domains. While it is well-known that pro-environmental behaviours often correlate across domains, the reasons for this correlation are poorly understood. For example, households who are conscientious about their water use tend to be the same about their energy use or the amount of waste that they generate. It is tempting to attribute such an alignment of pro-environmental behaviours to environmentalist or conservationist worldviews, and certainly such attitudes clearly play a role in determining behaviour.[6] But it is not often analysed to what extent similarities in environmental behaviours across domains can be fully attributed to expressed pro-environmental worldviews. Better understanding this relationship is relevant for policy, because it is associated with the question of whether policies in one domain (e.g. unit-based prices for water use or waste collection) can have spillover effects in other domains (e.g. greater home energy conservation or more sustainable driving-transport habits). In some cases conservation efforts in different domains may be technological complements (or substitutes), while in others they may be behavioural complements (or substitutes).

If cross-domain correlations in behaviours arise for reasons beyond simple attitudinal orientations, then there may be opportunities for designing portfolios of environmental policies which are based on this knowledge and which interact more efficiently. For example, this paper's analysis provides evidence of a strong cross-domain correlation in behaviours which cannot be accounted for through the available attitudinal metrics, i.e. an expressed environmentally motivated or sceptical worldview. Thus this evidence suggests (but does not confirm) that practicing a conservation-oriented behaviour in one domain, such as water conservation, may increase the likelihood of also practicing such behaviours in other domains, such as energy conservation. This observation provides a useful hypothesis for further testing with additional data (ideally in an experimental format).

Subsequent sections describe the econometric methods used to generate the results summarized above, present the detailed findings and conclude by discussing possible explanations for these results.

[6] As often confirmed in the thematic papers. See OECD (2014). See also the overview of results from econometric analysis using the 2011 household survey (OECD, 2014).

## ANALYSIS OF NEIGHBOURHOOD EFFECTS AND KEY VARIABLES

To investigate the extent to which respondents' attitudes, socioeconomic characteristics, and environmental behaviours are related to those of their neighbours, a distance weighting formula is applied to a set of binary variables to generate corresponding neighbourhood averages. For a set of $K$ binary indicators $(y_{i1}, \dots, y_{iK})$ for respondent $i$, the corresponding neighbourhood average for each indicator is calculated as:

$$y_{ik}^{*} = \frac{\sum_{j \neq i} \exp\left(-\theta \frac{d_{ij}}{\bar{d}_i}\right) y_{jk}}{\sum_{j \neq i} \exp\left(-\theta \frac{d_{ij}}{\bar{d}_i}\right)} \qquad k = 1, \dots, K \tag{1}$$

where the $y_j$'s comprise the same indicators, but for all other respondents (indexed by $j$), $d_{ij}$ is the geographic distance between the residences of respondents $i$ and $j$, and $\bar{d}_i$ measures the degree to which respondent $i$ is isolated from the rest of the sample (and by inference the population), calculated as $\bar{d}_i = \sum_{j \neq i} d_{ij} / (N-1)$. The parameter $\theta$ is a spatial weighting factor such that, as $\gamma$ increases, more weight is given to values coming from relatively closer neighbours: When $\theta = 0$, then all values are weighted equally in the calculation of $y_i^*$, and when $\theta = \infty$ then $y_i^*$ simply equals the value of the indicator for respondent $i$'s closest estimated neighbour (or neighbours, in the case of ties) in the dataset. The weights are a function of relative distance, i.e. taking the exponential of $d_{ij}/\bar{d}_i$ rather than simply $d_{ij}$, in order to control for the fact that, the more isolated a respondent is, the less information the analyst has to weight any other respondent in the sample, because they are all so distant. These indicators are computed at a country level so that the $y_j$'s come from all respondents in the same country as respondent $i$'s. The distance measures $d_{ij}$ are obtained by mapping the geographical centroid of respondents' postal codes to longitude and latitude coordinates, and then using the Haversine formula to compute spherical distances between these coordinates. These measures are thus approximations; for example, any respondents in the same postal code are estimated to be separated by a distance of zero. The spatial weighting factor $\theta$ is selected according to a technical procedure described in an annex to the paper.

Table 1 gives a sense of how successful the geocoding was, and the spatial distribution of the sampled households. Over 85% of sampled households were successfully geocoded in six countries – Australia, Canada, France, the Netherlands, Spain and Sweden. Households in the Japanese and Swiss samples were also geocoded, but to a lesser degree (53% and 34%). The remaining three samples (for Chile, Israel[7] and Korea) were unable to be geocoded, and were thus excluded from the rest of the analysis in this paper.

The set of variables used in this spatial analysis include indicators of environmental attitudes, civic engagement, and socioeconomic attributes. Table 2 lists these variables, their weighted-mean percentages for the pooled sample (applying sampling weights), as well as the correlation between respondents' own

[7] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

indicators and the average for their neighbourhood (i.e. the correlations between $y_{ik}$ and $y_{ik}^{*}$). A complete description of these variables with additional summary statistics and descriptive analysis by country can be found in OECD (2014, Chapter 2).

**Table 1. Geocoding household locations and spatial distribution of the sample**

| | Observations geocoded | Per cent of full sample | Distance to nearest, in-sample neighbour | | |
|---|---|---|---|---|---|
| | | | *25th percentile* | *50th percentile* | *75th percentile* |
| Total | 7,451 | 61% | 0.00 | 1.43 | 4.74 |
| Australia | 976 | 98% | 0.00 | 0.00 | 3.41 |
| Canada | 1,120 | 99% | 0.79 | 1.91 | 4.89 |
| Chile | 0 | 0% | - | - | - |
| France | 1,170 | 95% | 0.00 | 2.94 | 10.52 |
| Israel | 0 | 0% | - | - | - |
| Japan | 556 | 53% | 1.43 | 2.94 | 7.00 |
| Korea | 0 | 0% | - | - | - |
| Netherlands | 1,286 | 99% | 0.00 | 0.70 | 2.24 |
| Spain | 1,062 | 99% | 0.00 | 0.71 | 4.70 |
| Sweden | 882 | 87% | 0.38 | 1.55 | 4.85 |
| Switzerland | 372 | 34% | 0.00 | 1.97 | 4.78 |

The attitudinal indicators on which this paper focuses involve a set of rankings of how concerned respondents are with six different global issues (including environmental problems). Also analysed are attitudes specifically towards environmental issues – the believability of claims about environmental problems, who bears responsibility for fixing them, and the best means for fixing them are achieved through a previously presented cluster analysis. Based on expressed levels of agreement or disagreement with six statements about the environment (e.g. "environmental impacts are frequently overstated," "environmental issues will be resolved in any case through technological progress"), each respondent was assigned to one of three statistically identified attitudinal classes. The first class, comprising 41% of the sample (after geocoding), are labelled as "environmentally motivated." These individuals believe claims about environmental problems and think that substantial compromises in material wellbeing will be necessary to solve these problems. An additional 18% are labelled as "technological optimists." These respondents also believe claims made about environmental problems, but think that technological progress will provide the means for solving them. The remaining 41% are "environmental sceptics." They principally believe that environmental problems are frequently overstated and are thus hesitant to invest in solving them. Details of the classification methods are in the annex.

**Table 2. Summary statistics for variables analysed for neighbourhood effects**

| | Percentage of respondents (pooled, weighted sample) | Neighbourhood correlation[1] |
|---|---|---|
| *Top-ranked concern/issue*[2] | | |
| Economic concerns | 45% | 0.13 |
| Environmental concerns | 13% | 0.06 |
| Health concerns | 12% | 0.04 |
| International tensions | 11% | 0.07 |
| Personal safety | 5% | 0.03 |
| Social issues | 14% | 0.10 |
| *Environmental attitude clusters*[3] | | |
| Environmentally motivated | 41% | 0.13 |
| Technological optimists | 18% | 0.07 |
| Environmental sceptics | 41% | 0.04 |
| *Indicators of civic engagement* | | |
| Vote in local elections | 74% | 0.10 |
| Charity member | 22% | 0.20 |
| PTA member[4] | 10% | 0.01 |
| Community org. member | 14% | 0.06 |
| Environmental org. member. | 8% | 0.06 |
| Member of other organization | 19% | 0.06 |
| *Behavioural indicators*[5] | | |
| Energy conservation | 48% | <0.01 |
| Water conservation | 49% | 0.02 |
| Waste prevention | 49% | 0.05 |
| Percent high-income[6] | 42% | 0.11 |
| Percent 4+ years university | 46% | 0.15 |
| Percent unemployed | 6% | 0.06 |
| Observations | 7,451 | |

Sampling weights applied to all figures in this table. [1] The neighbourhood correlation for a variable $y$ is defined as the correlation between $y$ and the weighted average value $y^*$ of the variable among nearest neighbours. [2] Respondents were asked to rank six global issues in terms of how concerned they were. [3] Latent class analysis (LCA) was applied to a set of environment-related attitudinal questions, resulting in three statistically significant classes. See OECD (2014) for details on the LCA procedure. [4] PTA = Parent Teacher Association. [5] The definition of these behavioural indicators is defined below, in a later section. [6] "High-income" is defined as being above the 5th income decile, based on prior national statistics. The mean percent here is lower than 50% (corresponding to a true median), because (a) the sample used here is a subsample of the full dataset and (b) the income decile brackets utilized in the survey did not correspond exactly to actual deciles at the time of implementation.

In some cases these attitudinal indicators appear correlated within neighbourhoods. For example, there is a relatively significant positive correlation of 0.13 between a respondent ranking economic concerns as comprising the most important global issue and her neighbours doing the same, a pattern which is mirrored in the percentage ranking social issues as most important. The ranking of environmental concerns relative to other global issues slightly correlates across space, but to a lesser degree. However, those classified as "environmentally motivated" are likely to live near those classified similarly, with a spatial correlation of 0.13.

Six behavioural indicators of civic engagement are analysed, the most frequent of which is voting in local elections: Nearly three-quarters of the weighted sample having voted in local elections within the last six years. Furthermore, such voters are likely to reside near others who also voted in local elections, with a neighbourhood correlation of 0.10. The next most frequent indicator is membership in a charity, with 22% belonging to such organizations. Furthermore, this indicator exhibits the strongest neighbourhood correlation, at 0.20, from among all of those analysed. Belonging to an environmental organization is the most infrequently arising indicator, with only 8% of the weighted sample belonging to such organizations. There is a small neighbourhood correlation of 0.06 associated with this indicator.

Unsurprisingly, socioeconomic characteristics of households also correlate spatially. Households with higher income and education tend to reside near one another, with correlations of 0.11 and 0.15 respectively for income and education indicators, respectively. In real terms 36% of neighbours around an average low-income (below median) household in the sample are likely to be classified as high-income, whereas 40% of neighbours around a high-income household are themselves likely to be high-income. Similarly, the average neighbour of an individual with four or more years of university-level of education is 6% more likely to have an equivalent level of education than if he lived near someone with less education. Unemployment also tends to correlate to some degree within neighbourhoods.

## DETERMINANTS OF CIVIC ENGAGEMENT AND THE ROLE OF NEIGHBOURHOOD EFFECTS

To identify the factors determining the likelihood of engaging in the civic engagement indicators described above, the following general probit regression model is used for each indicator $k$:

$$\tilde{y}_{ik} = \alpha_k y^*_{ik} + \beta_k X_i + \beta^*_k X^*_i + \epsilon_{ik} \quad (2)$$

where $\tilde{y}_{ik}$ is a latent variable corresponding to the indicator $y_{ik}$ such that when $\tilde{y}_{ik} > 0$ then $y_{ik} = 1$ (with $y_{ik} = 0$ otherwise). The econometric error $\epsilon_{ik}$ is assumed distributed normally which gives us the probit regression model. The estimated neighbourhood effect $\alpha_k$ measures how much the neighbourhood average for the indicator $y^*_{ik}$ influences' respondents own values for $y_{ik}$. This regression equation also distinguishes the role of respondents' own characteristics (captured by $X_i$) from other neighbourhood characteristics (captured by $X^*_i$). The neighbourhood-level factors analysed are three: The estimated fraction of neighbouring households with incomes above the national-level median, the fraction with four or more years of university-level education, and the neighbourhood unemployment rate.

Interpreting the regression results, presented as marginal effects in Table 3, neighbourhood effects are significant (and positive) for half of the indicators – voting in local elections, and membership in a PTA or community organization. The largest neighbourhood effect emerges with respect to voting in local elections: A 10% increase in the participation of an individual's neighbours in local elections is associated with an estimated 1.5% increase in the likelihood that the individual herself votes.

At the community level, neither relative income nor the unemployment rate of an individual's neighbourhood appears to independently determine an individual's levels of civic engagement, at least with respect to the indicators considered here. Curiously, higher levels of university education in an individual's neighbourhood appear to predict a slightly decreased likelihood of voting in local elections.

It is of primary interest to note the lack of any statistically significant neighbourhood effect associated with membership in environmental organizations (despite observing a positive spatial correlation in the descriptive statistics in Table 2). This null result suggests that environmental activism may be less spatially dependent than some other forms of civic engagement. For example, environmental activism may be more amenable to internet-based engagement. However, the overall low rate of membership in environmental organizations limits precision in the estimated neighbourhood effects, giving reason for caution in interpreting the results. Nevertheless, the null result suggests a hypothesis for future testing.

Respondents' own attributes determine their levels of civic engagement in relatively intuitive ways. Above-average income is tied to higher levels of civic engagement (note this does not identify the causal relationship between these two factors), and conversely unemployment is clearly linked to lower levels of engagement. Similarly, a university education is also associated with greater engagement in organizations, though not necessarily a greater frequency of voting. Women are more likely to belong to PTAs and charities, and somewhat less likely to belong to other organizations, though the estimate of this latter effect is not very precise. Older individuals are more likely to vote in local elections, and to belong to charities and local community organizations, but younger individuals are more likely to belong to environmental organizations and PTAs.

The attitudinal metrics also predict levels of engagement in expected ways: For example, people ranking environmental concerns more highly relative to other issues (with economic concerns being the reference category) are more likely to belong to an environmental organization. Those relatively more concerned with international tensions are more likely to belong to charities. Finally, individuals' relative concern for "social issues" appears to be associated with multiple indicators of civic engagement – membership in charities, community organizations as well as environmental organizations.

## DOES CIVIC ENGAGEMENT AFFECT ENVIRONMENTAL ATTITUDES?

As seen above there is a significant link between various indicators of civic engagement and attitudes towards the environment. And as discussed in the introduction, the causal effects may run both ways: For example, those strongly concerned about environmental issues may be more likely to vote and/or to engage with organizations, particularly environmental organizations. But at the same time involvement in various organizations – and more involvement in one's community/government generally – may shape attitudes about the environment, as well as other issues.

To probe these causal pathways, we focus on the following probit regression equation in this section:

$$\mathrm{S}_i = \eta \mathrm{Engage}_i + \beta X_i + \beta^* X_i^* + \epsilon_i \qquad \text{such that} \qquad \mathrm{Sceptic}_i = 1 \text{ when } \mathrm{S}_i > 0 \tag{3}$$

where $\mathrm{Sceptic}_i$ indicates whether respondent $i$ is estimated to belong to the "environmental sceptics" class as defined above (otherwise, she belongs to the "environmentally motivated" or "technological optimists" classes). The key explanatory variable here is $\mathrm{Engage}_i$, which is an index of civic engagement formulated as a simple sum of the indicators heading the columns of Table 3. This constructed index is well-behaved and has a smooth distribution, as displayed in the annex. The other variables $X_i$, $X_i^*$ and $\epsilon_i$ are as above.

Instrumental variables (IV) methods are used to address endogeneity, allowing us to investigate the two directions of causality hypothesised above (e.g. sceptics being less likely to be civically engaged, and people perhaps becoming more or less sceptical of environmental issues and policies as a result of their experiences in volunteer organizations). Specifically, the variable $\mathrm{Engage}_i$ is instrumented using the average neighbourhood level of engagement surrounding respondent $i$.

Table 4 presents both the first- and second-stage IV results from such a regression, as well as results from a "naïve" probit (i.e. with no instrumental variables). The results are striking and somewhat surprising: First, the instrument – community-level civic engagement – appears to be an effective instrument for own-respondent civic engagement (looking at the last column of Table 4). Subsequently, results imply that greater civic engagement appears to lead to greater scepticism about environmental claims and policies aimed at addressing them. In terms of the marginal effects, the estimates imply that if an individual somehow transitions from the 25$^{th}$ to the 75$^{th}$ percentile of the civic engagement index, then she is 22% more likely to be classified as "environmentally sceptical," based on her survey responses.

The results reveal strong statistical evidence that endogeneity is present. The "cross equation correlation" at the bottom of Table 4 shows this; it measures the correlation between the econometric error $\epsilon_i$ and $\mathrm{Engage}_i$. If this correlation is zero, then the naïve regression is valid and thus preferred due to its greater statistical precision. But when this correlation is statistically different from zero, as is the case here, then there is evidence for endogeneity. Furthermore, this correlation is significantly negative which suggests – as expected – that those who are ex ante sceptical about environmental issues and policies are significantly less likely to engage in the types of civic engagement indicators analysed here. Thus, somewhat surprisingly, there appears to be a negative feedback between civic engagement activities and pro-environmental attitudes since the sign on "scepticism" is positive in the IV model. The net balance between these feedbacks can be roughly interpreted from looking at the naïve regression, which shows a significantly positive correlation between civic engagement and pro-environmental attitudes (and thus a negative coefficient with respect to membership in the sceptics' class). This parallels the results in Table 3. However, a policy implication from this regression is that when one finds evidence of a correlation between an individual's activity in some community, social or environmental organization and their propensity to engage in pro-environmental personal behaviours, it cannot then be inferred that increasing membership in such organizations will necessarily lead to greater pro-environmental behaviour in individuals' personal lives.

**Table 3. Determinants of civic engagement**

Marginal effects from probit regressions reported: Each estimate is the change in the mean likelihood of the dependent indicator (column title) from a one unit change in the explanatory factor (row variables), holding other factors constant. For discrete factors (e.g. high income, university, unemployed), the estimate is the change in the indicator's likelihood from a discrete change in the factor.

| | Vote in local elections | Charity member | PTA member | Community org. member | Env. Org. member | Member of other org. |
|---|---|---|---|---|---|---|
| Neighbourhood effect | 0.155*** | 0.134*** | -0.00761 | 0.0644** | 0.0332 | 0.0346 |
| | (0.0414) | (0.0340) | (0.0236) | (0.0316) | (0.0357) | (0.0399) |
| High income | 0.0787*** | 0.0606*** | 0.0598*** | 0.0322*** | 0.0263*** | 0.0228* |
| | (0.0161) | (0.0131) | (0.0102) | (0.0116) | (0.00791) | (0.0128) |
| University (4+ years) | 0.0150 | 0.0660*** | 0.0179* | 0.0310*** | 0.0305*** | 0.0467*** |
| | (0.0149) | (0.0123) | (0.00938) | (0.0114) | (0.00738) | (0.0123) |
| Unemployed | -0.0475* | -0.0503*** | -0.0102 | -0.0247 | -0.0181 | -0.0463** |
| | (0.0243) | (0.0188) | (0.0147) | (0.0208) | (0.0117) | (0.0194) |
| Female | -0.00371 | 0.0419*** | 0.0438*** | -0.0144 | 0.000561 | -0.0159 |
| | (0.0144) | (0.0119) | (0.00955) | (0.0110) | (0.00709) | (0.0118) |
| Age | 0.00720*** | 0.00203*** | -0.00105*** | 0.00308*** | -0.000384 | 0.00264*** |
| | (0.000519) | (0.000464) | (0.000282) | (0.000399) | (0.000311) | (0.000399) |
| *Top-ranked concern/issue* | | | | | | |
| Economic concerns (reference category) | -- | -- | -- | -- | -- | -- |
| Environmental concerns | -0.0478* | 0.0325* | 0.0201 | 0.0285 | 0.135*** | 0.0121 |
| | (0.0260) | (0.0181) | (0.0166) | (0.0188) | (0.0164) | (0.0187) |
| Health concerns | -0.0200 | 0.00576 | -0.0170 | -0.00817 | 0.00878 | -0.0223 |
| | (0.0214) | (0.0175) | (0.0122) | (0.0163) | (0.0109) | (0.0174) |
| International tensions | -0.0154 | 0.0423** | 0.0120 | 0.0157 | 0.00542 | 0.00848 |
| | (0.0225) | (0.0198) | (0.0176) | (0.0182) | (0.00984) | (0.0186) |
| Personal safety | -0.0456 | -0.0245 | 0.0353* | 0.0258 | -0.0101 | 0.0142 |
| | (0.0282) | (0.0227) | (0.0207) | (0.0238) | (0.0120) | (0.0262) |
| Social issues | 0.000600 | 0.0749*** | 0.0248 | 0.0303* | 0.0437*** | 0.0614*** |
| | (0.0215) | (0.0212) | (0.0158) | (0.0174) | (0.0157) | (0.0204) |
| *Other n-hood attributes* | | | | | | |
| Fraction high income | -0.0324 | 0.00244 | -0.0347 | -0.0316 | 0.00129 | -0.0260 |
| | (0.0351) | (0.0369) | (0.0218) | (0.0280) | (0.0231) | (0.0317) |
| Fraction 4+ years univ. | -0.0619* | 0.0110 | -0.0158 | -0.0220 | -0.0102 | -0.00282 |
| | (0.0330) | (0.0287) | (0.0210) | (0.0273) | (0.0210) | (0.0300) |
| Fraction unemployed | -0.0490 | -0.0629 | 0.00175 | -0.0152 | -0.0402 | -0.0326 |
| | (0.0548) | (0.0427) | (0.0298) | (0.0410) | (0.0295) | (0.0461) |
| Pseudo-$R^2$ | 0.08 | 0.10 | 0.05 | 0.05 | 0.09 | 0.04 |
| log-likelihood | -100 x$10^6$ | -89 x$10^6$ | -59 x$10^6$ | -72 x$10^6$ | -48 x$10^6$ | -88 x$10^6$ |
| Observations | 7,451 | 7,451 | 7,451 | 7,451 | 7,451 | 7,451 |

Standard errors in parentheses, computed using the delta-method, based on robust standard error estimates in the regressions. Statistical significance denoted by *** p<0.01, ** p<0.05, * p<0.1. Country-level fixed effects included in all regressions but not shown.

**Table 4. Regression estimates of the effects of civic engagement on attitudes**

Probit regression estimating the factors affecting membership in the sceptics' attitudinal class, relative to the technological optimists and the environmentally motivated.

| | Environmental sceptics (naïve probit) | Environmental sceptics (IV probit) | Civic engagement index (1st stage of IV) |
|---|---|---|---|
| Civic engagement index | -0.0938*** | 0.723*** | |
| | (0.0201) | (0.19) | |
| Neighbourhood effect from civic engagement | | | 0.0808** |
| | | | (0.0378) |
| High income | 0.00515 | -0.201*** | 0.263*** |
| | (0.0463) | (0.062) | (0.0348) |
| University (4+ years) | -0.0369 | -0.174*** | 0.197*** |
| | (0.0457) | (0.0453) | (0.0335) |
| Unemployed | -0.196** | 0.0391 | -0.200*** |
| | (0.0797) | (0.102) | (0.0537) |
| Female | -0.300*** | -0.221*** | 0.0491 |
| | (0.0434) | (0.0732) | (0.0322) |
| Age | 0.00352** | -0.00848*** | 0.0136*** |
| | (0.00167) | (0.00328) | (0.00118) |
| *Other n-hood attributes* | | | |
| Fraction high income | -0.0453 | 0.0444 | -0.113 |
| | (0.113) | (0.0997) | (0.0853) |
| Fraction 4+ years univ. | -0.158 | -0.0179 | -0.0939 |
| | (0.108) | (0.106) | (0.0785) |
| Fraction unemployed | 0.0377 | 0.169 | -0.165 |
| | (0.157) | (0.136) | (0.118) |
| Fraction in sceptics class | 0.00426 | 0.0113 | -0.000806 |
| | (0.108) | (0.0906) | (0.0845) |
| Cross equation correlation | | -0.678** | |
| | | (0.139) | |
| Observations | 7,451 | 7,451 | |
| Log-likelihood | -1.24 x10$^{8}$ | -3.95 x10$^{8}$ | |

Robust standard error estimates in parentheses. Statistical significance denoted by *** p<0.01, ** p<0.05, * p<0.1. Country-level fixed effects included in all regressions but not shown.

## CROSS-DOMAIN BEHAVIOURAL SPILLOVERS AND THE INTERACTION BETWEEN POLICIES AND ATTITUDES

The above analysis of environmental attitudes – how they evolve and are codetermined with community activism – is instrumental in understanding differential responses in individual behaviours within specific thematic domains such as energy and water conservation or waste prevention. This section therefore empirically analyses the following questions:

- To what extent do cross-domain spillovers exist and how much can environmental attitudes account for them?
- How do environmental attitudes mediate the effects of policy measures on affecting behaviours?
- As examined above with attitudinal factors, are their neighbourhood effects in pro-environmental behaviours?

To retain comparability across domains, the analysis here utilizes aggregated behavioural indices for each of three environmental domains – energy, water and solid waste. To keep the units of the outcome variables meaningful, the analysis further reduces these indices to three corresponding binary indicators of whether the respondent is above her country-level median for that domain. For example, in the case of waste prevention, a respondent is classified as engaging in "above-average" waste prevention if her household generates less per capita mixed waste than the median for her country. The econometric analysis applies a seemingly unrelated probit regression using these three binary behavioural indicators as dependent variables. The system of regression equations takes the following general form:

$$
\begin{aligned}
e_i &= \beta_S^e \text{Sceptic}_i + \beta_P^e \text{Policy}_i + \beta_{S\times P}^e (\text{Sceptic}_i \times \text{Policy}_\text{i}) + \beta^e X_i + \beta^{e*} X_i^* + \nu_i \\
w_i &= \beta_S^w \text{Sceptic}_i + \beta_P^w \text{Policy}_i + \beta_{S\times P}^w (\text{Sceptic}_i \times \text{Policy}_\text{i}) + \beta^w X_i + \beta^{w*} X_i^* + \omega_i \\
g_i &= \beta_S^g \text{Sceptic}_i + \beta_P^g \text{Policy}_i + \beta_{S\times P}^g (\text{Sceptic}_i \times \text{Policy}_\text{i}) + \beta^g X_i + \beta^{g*} X_i^* + \zeta_i
\end{aligned}
\qquad (4)
$$

Here, $e_i$, $w_i$ and $g_i$ are latent indicators for energy, water and waste conservation/prevention (use the mnemonic $g$ = "garbage"). The econometric error terms $\nu_i$, $\omega_i$ and $\zeta_i$ are statistically distributed jointly normal (the definitive characteristic of the seemingly unrelated probit model), and the correlation between these error terms represents the degree to which the corresponding behaviours are correlated beyond that accounted for by the explanatory factors. The $\beta$'s are the estimated effects of the explanatory factors on behaviours.

The primary explanatory factors of interest are those related to policies, represented in the equations above by the vector $\text{Policy}_i$. The regression includes three policy-related indicators, one associated with each of the behavioural indicators: whether the household has been offered time-of-use (TOU) pricing for

electricity,[8] whether the household is subject to a unit-based water charge and whether the household faces a "pay-as-you-throw" (PAYT) charge for mixed waste collection (usually based on weight or volume). Details and summary statistics for these indicators can be found in OECD (2014). All three indicators are included in each regression equation above in order to test for the presence of policy spillovers.

To study the effects of environmental attitudes on behaviours, and how these attitudes potentially mediate the effects of policy, the variable $\text{Sceptic}_i$ is included in the regression, which indicates whether or not the respondent is estimated to belong to the "environmental sceptics" attitudinal class (as opposed to the "environmentally motivated" or "technological optimists" classes), based on the LCA procedure described in OECD (2014, Chapter 2). The attitudinal indicator is interacted with the vector of policy indicators (represented by $\text{Sceptic}_i \times \text{Policy}_\text{i}$), in order to see if those classified as sceptics appear to respond differently to policy measures than those who appear less sceptical about claims asserting the presence of environmental problems.[9]

As with the above regressions, both the personal characteristics of each individual and her household (represented as $X_i$), as well as neighbourhood characteristics (represented as $X_i^*$), are included in the analysis. In this case the vector of neighbourhood factors $X_i^*$ also includes the neighbourhood averages of all three behavioural indicators, i.e. the fraction of people engaging in above-average energy conservation ($Y_i^*$), water conservation ($W_i^*$) and waste prevention ($G_i^*$).

Table 5 presents the results. Beginning at the end of the table, one sees that residual correlations are positive and significant across all three behavioural indicators. This means that the explanatory variables in the regression – including the attitudinal factors – are unable to account for all of the correlation in these behaviours. That is, these results suggest that there are further unobserved factors, beyond the pro-environmental attitudes measured here, which explain an individual who engages in high levels of energy conservation is significantly more likely to do the same with respect to water conservation and waste prevention. There are a range of psychological explanations which might account for this "non-attitudinal behavioural correlation." Some of these are discussed at the conclusion of the paper, but ultimately additional expertise from psychologists is necessary to extrapolate from these results.

Examining the effects of policy on these behaviours, we see that each policy indicator indeed has a significant impact on its targeted domain, but not in other domains. TOU electricity pricing is linked with a mean 12% increase in the likelihood that the individual engages in above-average energy conservation behaviours. Facing unit-based charges for water use are meanwhile linked to an average 9% increase in the likelihood of engaging in above-average water conservation efforts. And PAYT mixed waste collection is associated with a 24% increase that an individual is above-average in their waste prevention efforts (i.e.

[8] It is arguable whether TOU pricing would be expected to increase – or possibly decrease – home energy conservation behaviours. TOU pricing encourages consumers to shift their energy use from high-demand (and thus higher-priced) periods of the day to low-demand periods. While there are clear efficiency gains from smoothing demand across the whole day, there is no economic logic that necessarily implies consumers reduce their overall demand throughout the day. However, TOU may affect certain energy-use behaviours which are more inelastic with respect to shifting to different times of day, due to rigidities in homeowners' schedules (e.g. workday patterns). Such behaviours, contained in the energy conservation index used here, include using less heating or air conditioning, turning off lights when leaving a room, running fewer but fuller dishwasher or laundry machine loads, or air drying laundry rather than using a clothes dryer.

[9] In principle it would be straight-forward to include one of the other two classes produced from the LCA in the regression, as a main effect and an interaction with the policy variables. However, this makes the results difficult to present and impedes interpretation, without adding additional insight.

that they generate below-average amount of mixed waste). Thus, we find no evidence for any policy spillovers with respect to the three behavioural indicators and associated policy variables examined here.

Environmental attitudes do appear to mediate the effects of policy. In the domains of energy and water conservation, only the non-sceptics (those who appear to believe claims affirming the presence of environmental problems) appear to respond to the associated policy levers (TOU energy pricing and unit-based water charges). In fact, the entire, measureable effect of the policies in these two cases appears to come entirely from the non-sceptics, i.e. either the "environmentally motivated" or "technological optimist" classes. In contrast, environmental sceptics are much more responsive to PAYT waste collection charges, and in fact the entire effect of this policy seems to come from this group. Reasons for the differential distribution of policy effects across domains and attitudinal orientations are discussed below.

On the question of whether there are neighbourhood effects on the behavioural indicators examined here, a statistically significant direct effect arises only in the case of waste prevention: Households in neighbourhoods exhibiting high levels of waste prevention are 20% more likely to themselves also be above-average in this domain, compared to households in neighbourhoods exhibiting low-levels of waste prevention. There is also some evidence of an indirect negative effect of relative neighbourhood income on an individual's own energy conservation efforts: A household in a high-income neighbourhood is 20% less likely to be engaged in above-average private energy conservation activities than a household in a low-income neighbourhood (although this estimate excludes investments in energy efficiency products, which may be higher in high-income areas).[10]

Turning finally to the links between the behavioural indicators and the socioeconomic characteristics of individuals and their households, perhaps the most striking finding is the uniformly negative effect that higher income appears to have on pro-environmental behaviours. The direction of the relationship is not what is surprising as the thematic papers presenting the results of econometric analysis show.[11] It is often found that higher incomes are associated with greater energy and water use, as well as waste generation, all other factors being equal. What is striking, however, is that the magnitude of these effects are so uniform across all three behavioural indicators. An individual belonging to a high-income household is about 20% less likely to engage in above-average energy or water conservation, or waste prevention. The effect of individuals' age, too, appears to be fairly uniform across indicators, this time in a positive direction: Every ten-year increment in an individuals' age is associated with a 5-7% *increase* in the likelihood that she engages in any of the three indicative behaviours. One important point in interpreting this finding, however, is that due to the cross-sectional nature of the dataset it cannot be discerned whether the age effect is associated with generational differences (i.e. between 'baby boomers' and 'Generation X,' etc.), or with an actual evolution of behaviours that coincides with individuals' aging.

[10] See the five thematic papers presenting the results of econometric analysis in (OECD, 2014).

[11] See (OECD, 2014).

**Table 5. The effects of attitudes, policies and their interactions on behavioural indicators**

Marginal effects presented.

| | *Seemingly-unrelated probit regression with above-average…* | | |
|---|---|---|---|
| | *Energy conservation* | *Water conservation* | *Waste prevention* |
| Environmental sceptic | -0.0690 | 0.00567 | -0.124 |
| | (0.0754) | (0.0771) | (0.0773) |
| *TOU electricity pricing* | | | |
| Among sceptics | 0.0597 | -0.00166 | -0.0167 |
| | (0.0718) | (0.0771) | (0.0775) |
| Among non-sceptics | 0.168*** | 0.0721 | -0.0389 |
| | (0.0582) | (0.0591) | (0.0590) |
| *Unit-based water pricing* | | | |
| Among sceptics | 0.0276 | -0.00338 | 0.0882 |
| | (0.0746) | (0.0778) | (0.0793) |
| Among non-sceptics | 0.0820 | 0.145** | -0.00901 |
| | (0.0587) | (0.0585) | (0.0572) |
| *PAYT waste charges* | | | |
| Among sceptics | 0.117 | 0.127 | 0.353*** |
| | (0.120) | (0.123) | (0.121) |
| Among non-sceptics | -0.0940 | -0.131 | 0.167 |
| | (0.111) | (0.114) | (0.115) |
| High income | -0.173*** | -0.228*** | -0.211*** |
| | (0.0451) | (0.0462) | (0.0458) |
| University (4+ years) | 0.100** | -0.0276 | 0.0767* |
| | (0.0438) | (0.0442) | (0.0441) |
| Unemployed | 0.00287 | 0.0521 | -0.00898 |
| | (0.0763) | (0.0774) | (0.0765) |
| Female | 0.301*** | 0.0738* | 0.00584 |
| | (0.0419) | (0.0428) | (0.0426) |
| Age | 0.00793*** | 0.00500*** | 0.00615*** |
| | (0.00154) | (0.00157) | (0.00159) |
| *Neighbourhood effects* | | | |
| Fraction high-income | -0.230** | 0.00274 | -0.00877 |
| | (0.0964) | (0.0985) | (0.0984) |
| Fraction with 4+ years university | 0.0535 | 0.0264 | -0.0357 |
| | (0.0943) | (0.0964) | (0.0964) |
| Fraction unemployed | 0.0773 | -0.113 | -0.0224 |
| | (0.149) | (0.155) | (0.153) |
| Neighbourhood civic engagement | 0.0497 | 0.0141 | 0.0617 |
| | (0.0420) | (0.0440) | (0.0429) |
| Neighbourhood energy conservation | -0.0362 | -0.0648 | -0.0704 |
| | (0.0939) | (0.0958) | (0.0954) |
| Neighbourhood water conservation | -0.0747 | 0.0915 | 0.00788 |
| | (0.0938) | (0.0984) | (0.0973) |
| Neighbourhood waste prevention | 0.149 | -0.0645 | 0.199** |
| | (0.0918) | (0.0935) | (0.0937) |
| *Cross-equation correlations* | | | |
| Energy conservation | | | |
| Water conservation | 0.33*** | | |
| Waste prevention | 0.11*** | 0.14*** | |
| Joint log-likelihood | | $-3.78 \times 10^{8}$ | |
| Observations | | 7,451 | |

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Country-level fixed effects included in regression, but not shown.

## DISCUSSION

Several findings from the above analysis warrant explanation of possible mechanisms involved. The most surprising finding is the evidence that civic engagement may in some cases lead to increased environmental scepticism. One possible explanation here is that general civic engagement alters the relative importance which individuals' attribute to environmental problems, compared to other public issues such as poverty or access to education. It is conceivable that in communities with no outstanding local environmental problems, experiences in civic organizations enhance the saliency of local social issues, thus boosting the importance attributed to global social problems, such as gender or economic inequality, relative to environmental problems. To some extent this hypothesis could be investigated by analysing how the rankings of global concerns (see Table 2) may change in response to greater civic engagement. Such a hypothesis points to an immediate area for future analysis with these data.

Additionally, the nature – rather than the aggregate extent – of civic engagement surely plays a role in the formation of attitudes. For example, engagement in certain charities may enhance the perceived importance of eliminating poverty, relative to improving the environment, whereas the reverse might be the case when volunteering with environmental organizations. Unfortunately, the present data limit statistical inference in assessing such questions, due to the relatively small percentage of the sample engaged in the various indicators of civic activism. For instance, less than 10% of survey respondents are members of environmental organizations, whereas over 70% vote in local elections and 20% are members of charities. This distribution of engagement among qualitatively different activities may be the source of the surprising econometric results. For future analysis of similar data to identify attitudinal effects of different types of civic engagement, larger survey samples would be necessary (or, alternatively, oversampling respondents engaged in specific activities such as volunteering with environmental organizations, though this would require additional survey weighting).

The econometric results above also imply that the incidence of behavioural responses to incentive-based policies fluctuates across groups with different orientations of environmental attitudes, and that this incidence can itself vary across domain. While environmentally motivated individuals appear largely responsible for the significant behavioural responses to time-of-use electricity pricing and unit-water charging, environmental sceptics account for the majority of the behavioural response to PAYT waste charges. There are many possible explanations for this finding, including idiosyncratic factors related to which countries and regions tend to use the policies examined (see OECD 2014). But one possible explanation may be motivated by distinguishing between the direct economic and indirect, 'saliency' effects of incentive-based policies. The economic principle underlying the use of incentive-based policies is that the marginal cost of an activity such as waste generation or water use is supposed to be sufficiently large to incentivize a socially efficient level of that activity. With an appropriately established price for an activity such as waste generation, rational individuals find it in their self-interest to adjust their waste generation to efficient levels, regardless of whether or not they would call themselves "environmentalists." But establishing a price for an activity may also draw attention to that activity and make it more salient for individuals. For environmentally motivated individuals this increased saliency may lead them to adjust their behaviour merely because they are now paying more attention to the relevant behaviour: For example being offered time-of-use electricity pricing may lead individuals to contemplate and improve their energy conservation habits. Among environmental sceptics, however, such indirect, saliency effects are unlikely to manifest. One implication of this hypothesis is that incentive-based policies for which the price – though present – remains far below marginal cost, saliency effects are likely to dominate the direct economic

effect of the incentive, thus leading environmentally motivated people to respond more strongly than sceptics. Thus, if unit water prices for instance generally remain below the full marginal cost of provision, then the main effect of such incentives may be increasing saliency and garnering a response among environmentally concerned individuals. In contrast, the level of a unit-based charge for waste collection (PAYT) may be more economically meaningful, and in that case the direct economic effect of the policy may be the most meaningful.

An alternative explanation may originate from the fact that the water and energy conservation behaviours analysed here are derived from an index of stated habitual activities, whereas waste prevention behaviour is evaluated here purely in terms of physical waste generation (kilograms per person per week, though also elicited through a stated survey format, rather than observed). For a purely self-interested individual, the relevant metric is the financial bottom line and the activities directly affecting this. So in the case of energy and water conservation, the economically relevant metric is actual energy and water consumption, which is affected by many factors, such as energy/water efficiency investments, and not just habitual behaviours such as turning off the faucet or the lights. Similarly to the saliency argument presented above, sceptics may exhibit a greater response than the environmentally motivated on the most economically relevant dimensions, such as kilograms of waste generated, while in contrast the environmentally motivated may exhibit more of a response along instrumental dimensions, such as habitual behaviours. Such an explanation would explain why the estimated pattern of behavioural response to time-of-use electricity pricing aligns more closely with water pricing than with PAYT.

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## ANNEX 1

### *Calculation of spatial weighting factors*

The spatial weighting factor described at the beginning of this paper determines how much distance influences way that neighbours' behaviours is calculated to influence a respondents' own behaviour in the survey sample. For a given spatial weighting factor $\delta$ an indicator $y_{ik}$ for respondent $i$, the corresponding neighbourhood average $y_{ik}^{*}$ for that indicator surrounding respondent $i$ is:

$$y_{ik}^{*\delta} = \frac{\sum_{j \neq i} \exp\left(-\delta \frac{d_{ij}}{\bar{d}_i}\right) y_{jk}}{\sum_{j \neq i} \exp\left(-\delta \frac{d_{ij}}{\bar{d}_i}\right)} \qquad k = 1, \ldots, K \tag{A1}$$

$\theta$ is the spatial weighting factor, and as it increases, respondents closer to respondent $i$ are weighted more heavily in the calculation. As $\theta$ decreases distance matters less and less, and when $\theta = 0$ all other respondents are weighted equally in the calculation. Viewing $y_{ik}^{*}$ as a predictor of $y_{ik}$, the spatial weighting factors are calculated for each country $c$, and are computed using a least-squares criteria between the original indicators and the neighbourhood averages across all indicators considered, as follows:

$$\theta_c \equiv \arg\min_{\delta \geq 0} \frac{1}{K} \sum_{k=1}^{K} \frac{1}{N_c} \sum_{i_c=1}^{N_c} \left(y_{i_c k} - y_{i_c k}^{*\delta}\right)^2 \tag{A2}$$

### *Latent class analysis of environmental attitudes*

As mentioned above a latent class analysis (LCA) procedure was used to classify respondents into different groups on the basis of their responses to seven attitudinal statements about the environment, views towards the role of government and personal responsibility. A description and demonstration of LCA in the context of environmental attitudes can be found in Morey, Thatcher *et al.* (2006). LCA produces a number of useful statistical results: First, it can provide a statistically sound indication of how many attitudinal profiles—henceforth referred to as "classes"—can best represent the data at hand; secondly, it provides an estimate of likely responses to each of the seven attitudinal statements for an average member in each class; and finally, LCA provides an indication of which class each respondent most likely belongs to.

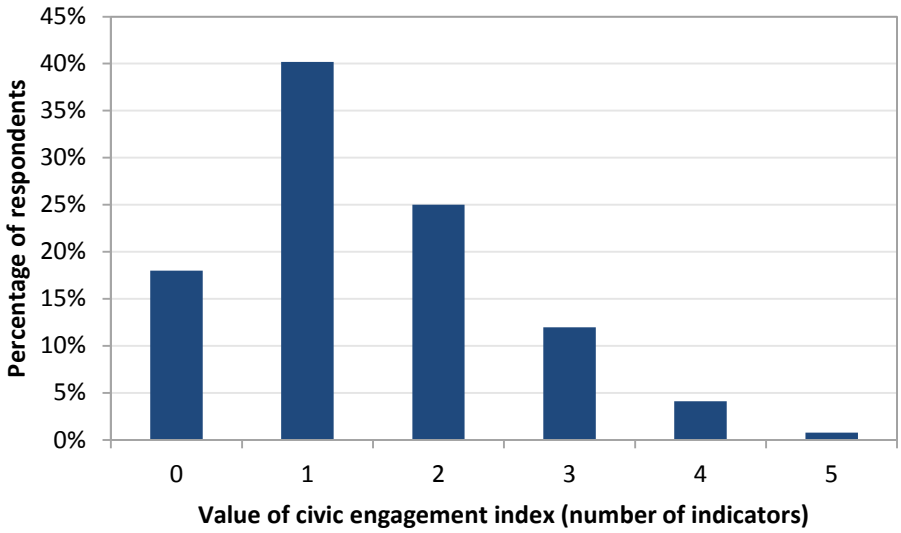
**Table A1. Results of latent class analysis of environmental attitudes**

| | | Classes | | | |
|---|---|---|---|---|---|
| | Pooled sample | ***Environmentally motivated*** | ***Environmental sceptics*** | ***Technological optimists*** | *Extreme responders* |
| Class size (percent of sample) | *100%* | *46%* | *32%* | *20%* | *2%* |
| *Policies introduced by the government to address environmental issues should not cost me extra money* | 63% | 57% | 77% | 61% | 0% |
| *I am willing to make compromises in my current lifestyle for the benefit of the environment* | 84% | 92% | 77% | 90% | 0% |
| *Protecting the environment is a means of stimulating economic growth* | 71% | 74% | 69% | 80% | 0% |
| *Environmental issues will be resolved in any case through technological progress* | 38% | 0% | 58% | 100% | 0% |
| *Environmental impacts are frequently overstated* | 35% | 0% | 100% | 0% | 0% |
| *I am not willing to do anything about the environment if others don't do the same* | 21% | 11% | 38% | 17% | 0% |
| *Environmental issues should be dealt with primarily by future generations* | 16% | 8% | 27% | 16% | 0% |

***Distribution of the civic engagement index***

As stated above an index of civic engagement was calculated by summing five different binary indicators of such activities (described above). As shown below this index exhibits a smooth distribution. Eighteen percent of the sample did not engage in any of the indicator activities, while less than 1% engaged in all five of the indicative activities.

**Figure A1. Distribution of the civic engagement index**



## ANNEX 2: DATA SOURCES AND LIMITATIONS

Based on a sample of more than 12 000 respondents in eleven countries,[12] this thematic report summarises main results on energy from the 2011 OECD periodic surveys on Environmental Policy and Individual Behaviour Change (EPIC) and draws evidence-based policy recommendations.[13] It builds on earlier work and supplements the overview of the 2011 survey data presented in OECD (2014).[14]

As in all studies involving primary data collection, there can be a sample bias when implementing a survey. Rigorous efforts were made at stratification and quota sampling. The sampling strategy involved stratification across region, gender, age and socio-economic status. The degree to which the country-level samples are representative of the national population is presented for a number of key variables in OECD (2014) in Annex B. However, in some countries (e.g. Chile and Switzerland) not all of these parameters could be included. Nonetheless, as Annex B in OECD (2014) shows, deviations in excess of 20% from representativity across these variables, for which quotas were set, were very limited. Response bias can be a second concern. It should be noted that such a bias is not specific to using internet panel-based surveys and responses can be biased by the interviewer in face-to-face interviews and telephone surveys. Given that the subject matter of the OECD survey is not related to information technologies or Internet, except for a very small number of questions (i.e. investment in "smart" meters), there is little reason to believe that this would result in a systematic bias.

It is also important for the reader to bear in mind the fact that all of the data used in the analyses reported here are based upon survey responses. This survey elicited respondents' stated preferences and perceptions. Therefore statistics reported here which relate to objective, verifiable indicators should be interpreted with caution and in some cases there may be 'measurement error'. On the one hand, this may relate to the dependent variable used in the studies. For example, estimates of waste generation and recycling rates may be inexact for some respondents. Similarly, estimates of the percentage of fresh fruit and vegetables consumed which is organic may also be inexact. On the other hand, some respondents may be mistaken about the precise nature of the policy measures to which they are subject. For example, it is possible that some respondents may not be aware that a given policy exists in their country. Similarly, some respondents may mistakenly believe that a policy exists in their country, when in fact it does not. However, it is important to note that for all questions in which there was significant potential for such "measurement error", respondents were given the option to respond that they "did not know" if such a policy was in place. This may relate to both "carrot" (i.e. grants for investment in energy-efficient devices, scrappage bounties for motor vehicles) and "stick" approaches (i.e. price-based measures). Given the large sample size, such observations should not affect the results in an important way. However, in order to ensure robustness of the results, a large number of models were estimated, including models with different country samples. Attention is drawn to important differences.

In general, readers should view these data as exactly what they are: the self-reported behaviours, attitudes and perceptions of representative samples of households from eleven OECD countries. Bearing the limits of such data in mind, it is important to recognise their advantages: information on households' knowledge and perceptions about environmental issues – increasingly recognised as a crucial factor for better understanding behavioural responses to environmental policies – is rarely analysed at such level of detail. Moreover, for many variables such as discrete choices about whether or not a given purchase has been made, there is likely to be very little deviation from a more formal household consumer survey.

[12] Australia, Canada, Chile, France, Israel, Japan, Korea, the Netherlands, Spain, Sweden and Switzerland. Approximately 1 000 households were surveyed in each country.

[13] The first survey was carried out in 2008 in ten countries with a sample of more than 11 000 respondents and the main results were presented in the OECD (2011).

[14] The full 2011 EPIC Survey questionnaire in English is provided in OECD (2014) in Annex A.