Investment in Energy Efficiency, Adoption of Renewable Energy and Household Behaviour: Evidence from OECD countries

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Abstract

There is a potential in residential sector to increase the share of renewable energy and to reduce the overall energy demand for a transition to a green economy. There is a huge literature on either demand for clean energy or investment in energy efficiency in the residential sector, but no specific study that investigates the behaviour of household to jointly adopt renewable energy and to invest in energy efficiency; and the relatedness of the two decisions. This paper fills this gap in literature and first shows that the two decisions of adopting renewable energy and of investing in energy efficiency are interrelated and cannot be estimated independently. As a result, univariate methods that estimate separately the two decisions of renewable adoption and energy efficiency potentially produce biased results because it may exist unobserved characteristics that determine both decisions. Second, the paper investigates characteristics of the household that significantly affect the interaction between the two decisions by using ordered probit model. More precisely, the paper provides evidence on factors that affect the joint probability of adopting renewable energy and investing in energy efficiency and the probability of doing nothing. The results show that ownership of primary residence, environmental concerns, commitment in environmental and local organizations, peak tariff, year and taking into account energy cost before renting or buying a house significantly affect the joint probabilities of adopting renewable energy and investing in energy efficiency at 1%. The joint decisions also significantly depends on climate change concerns and trust in local authorities at 5%, while it only significantly depends on trust in manufacturers, size of household and age at 10%. This contribution can serve to define incentives policies to boost energy transition.

Keywords: *Energy efficiency, renewable energy, bivariate probit, ordered probit.*

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1 Introduction

The Renewable Energy (RE) represents a share of 19% of world final energy consumption in 2012 (REN21, 2014), while almost 60% of the world's electricity is consumed in residential and commercial buildings (IEA 2008a). More precisely, residential buildings contribute at 23% to the world final energy demand (IEA, 2007). Then, there exists a substantial potential in residential sector that can help to increase the share of RE through an introduction of clean energy in the electricity distribution. Investment in energy-efficient equipments in residential sector can also potentially contribute to reduce the overall consumption of energy. This investment can be undertaken through various residential channels of energy consumption. In the residential sector, cooking, lighting, water heating, appliances and space heating account for 5%, 5%, 16%, 21% and 53%, respectively (IEA, 2008b). For instance, curtailments or non-monetary energy saving investments (turning off light or turning down appliances, for instance) or monetary energy saving investments (bulb light or top-rate energy-efficient appliance, for instance) can help to substantially reduce energy consumption at the household level and then to contribute to reduce the overall energy demand.

Then, the two issues of clean energy adoption and investment in energy efficiency are both important for a transition to a green economy. There is a huge literature on either demand for clean energy (Gerpott and Mahmudova, 2010; Sardianou and Genoudi, 2013; Zhai and Williams, 2012) or investment in energy efficiency (Dietz et al., 2009; Heslop et al., 1981; Howarth, 1997; Urban and Scasny, 2012) in the residential sector. To our knowledge, there is no specific study that investigates the behaviour of household to jointly adopt renewable energy and to invest in energy efficiency; and the relatedness of the two decisions. This paper fills this gap in literature and first investigates whether the decision of household to adopt renewable energy and that of investing in energy efficiency in residential sector are related, by using bivariate probit model for a joint decision. Secondly, we investigate the determinants of the interaction between the two decisions by using ordered probit model. Basically, we intend to explain why some households decide to invest both in energy efficiency and in renewable energy, while others decide to only invest in renewable energy or to only invest in energy efficiency or to do nothing.

The survey on Environmental Policy and Individual Behaviour Change (EPIC) from the Organisation for Economic Co-operation and Development (OECD) is run in 2008 and 2011 across a number of countries and areas (energy, food, transport, waste and water) and provides evidence on what affects household decisions-making. However, the EPIC survey is not run on the same household over the two rounds and some countries were only surveyed in one round, but the two rounds are independent surveys. We then pool the two datasets from the six countries that were surveyed in the two rounds (Australia, Canada, France, Korea, Netherlands and Sweden) and we control for the effect of year. The survey provides the socio-economic and environmental factors, attitude and policy at the household level that can influence the real decisions of the household to invest in energy efficiency and to adopt renewable energy. We refer to RE as wind, solar, geothermal, hydro, etc. at the household level. The reduction of energy use can be driven by behaviour changes. For instance, scheduling efforts, turning off lights, cutting down on heating/air conditioning and switching off standby mode are behaviour changes or non monetary investment that household makes in order to consume less energy. Households can also undertake monetary investments to reduce their energy consumption. Notably, they can invest in low-energy appliances (Top-rated energy-efficient appliances, low-energy light bulbs, energy-efficient windows, etc.) or in energy efficient systems (automated control systems, domotic or home automation). Monetary investments imply that the household spends part of his income to consume less energy and contributes then to the overall pollution reduction.

The contribution of this paper is two-fold. First we show that the two decisions of adopting renewable energy and of investing in energy efficiency are interrelated and cannot be estimated independently. In fact, univariate methods that estimate separately the two decisions of renewable adoption and energy efficiency potentially produce biased results because it may exist unobserved characteristics that determine both decisions. Then, bivariate probit model is more appropriate than separate univariate probit models. Second, the paper investigates characteristics of the household that significantly affect the interaction between the two decisions. More precisely, the paper provides evidence on factors that affect the joint probability of adopting renewable energy and investing in energy efficiency and that of doing nothing by using ordered probit model. Basically, we intend to explain why some households decide to invest both in energy efficiency and in renewable energy, while others decide to only invest in renewable energy or to only invest in energy efficiency or to do nothing. The household that only adopts renewable energy or only reduces his energy consumption contribute to the energy transition better than the household who does nothing and less than the one who jointly adopts renewable energy and invests in energy efficiency. As the outcomes can be ranked, it requires the use of an ordered probit model. This contribution can serve to define incentives policies to boost energy transition. Note that this paper uses the two rounds surveys from six OECD countries as pooled data.

For the bivariate probit model, only the ownership of the residence and commitment in local organization have positive and significant effect on both decisions of renewable adoption and investment in energy efficiency. The total income of the household has significant effects neither on the decision of renewable adoption nor on the decision of investments in energy efficiency. Moreover, investment in energy efficiency significantly depends on specific environmental concerns such as climate change, resource depletion and waste generation, while adoption of renewable energy significantly depends only on general environmental issues. Finally, trusting information on environmental issues from any sources does not significantly affect the decision of household to reduce their energy use , while people who trust local authorities and manufacturers are more likely to invest in renewable energy.

For the ordered probit model, despite the fact that age (gender resp.) has significant effect on investment in energy efficiency (adoption of renewable energy resp.) and no significant effect on adoption of renewable energy (investment in energy efficiency resp.), gender has no effect on the joint decisions while age has a positive effect. Environmental concerns as well as specific issue such as climate change concerns and commitment in both local and environmental organizations increase the probability to adopt renewable energy and to invest in energy efficiency and decrease the probability to do nothing. Also, people who take into account energy cost before renting or buying a house are more likely to adopt renewable energy and invest in energy efficiency, and less likely to do nothing.

The remaining of the paper is structured as follow. In section 2, we provide literature on both adoption of renewable energy and investment in energy efficiency. In section 3, we describe the data and the method. Section 4 is devoted to the joint decisions, while section 5 focuses on the determinants of the interaction between the two decisions. Finally, we discuss the results and conclude in section 6.

2 Literature review

There is a huge literature on either demand for clean energy or investment in energy efficiency in the residential sector. In section 2.1, we provide some important studies on demand of clean energy and household behaviour while section 2.2 provides some analysis on household' behaviour to invest in energy efficiency. To our knowledge, there is no specific investigation of the simultaneous decisions of renewable energy adoption and investment in energy efficiency at household level. As the two decisions of adoption of renewable energy and investment in energy efficiency are taken by the same household in a residential sector and both issues are important in a transition to a green economy, an analysis of a joint decisions needs a particular attention.

2.1 Literature review on clean energy demand and household behaviour

There is an important literature on demand for green energy due to the importance of energy in CO2 emissions that induce climate change. Notably, in a residential sector, studies mainly focus on real behaviour or hypothetical behaviour to explain the decision of the household to adopt a renewable energy. However, the two approaches often give different results (Cameron et al., 2002; Kotchen and Moore, 2007 and Poe et al., 2002). The hypothetical behaviour based on stated-preference methods can rely on the willingness decision to adopt a renewable energy (Gerpott and Mahmudova, 2010; Ozaki, 2011; and Zhai and Williams, 2012; and Sardianou and Genoudi (2013)), on the willingness to pay for a renewable energy (Ek and Söderholm, 2008; Zoric and Hrovatin, 2012; Liu et al., 2013.) or on both decisions (Krishnamurthy et al., 2014; and Shi et al., 2013).

Gerpott and Mahmudova (2010) finds a strong influence of environmental attitudes of the consumer and its social environment on the propensity to adopt green electricity. In contrast, Ozaki (2011) uses correlation analysis and finds that pro-environmental consumers do not necessarily adopt green electricity. This is a result of lack of strong social norms and personal relevance that affect the adoption of renewable energy as well as the value of the renewable energy (benefits and costs). Additionally to environmental concern, Zhai and Williams (2012) investigate the influence of social acceptance and show in a specific case of photovoltaics (PV) adoption that social acceptance also affects the adoption of renewable energy. Financial incentives through tax of subsidy are also important to promote adoption of clean energy. Sardianou and Genoudi (2013) finds in Greece that a tax deduction is better than an energy subsidy to promote consumers' acceptance of renewable energies in the residential sector.

Substantial studies investigate the willingness to pay for a renewable energy. Ek and Söderholm (2008) investigate norm-motivated and economic-motivated behaviour in the Swedish green electricity market. They find that variables such as cost of adoption, personal responsibility, perception of the benefit of adoption and social norm are the most important determinants of households' choice to pay a price premium for green electricity. Zoric and Hrovatin (2012) suggest that awareness-raising campaigns should follow green marketing, which should target younger, well-educated and high-income households. In a specific case of developing countries, Liu et al. (2013) investigate rural social acceptance of renewable energy adoption and find that rural residents are generally supportive renewable electricity development given its positive impacts on environment. Krishnamurthy et al. (2014) and Shi et al. (2013) focus on the the willingness to accept and the willingness to pay to use only renewable energy and their disparities across OECD countries. The former uses the 2011 EPIC-OECD survey while the latter uses the 2007 EPIC-OECD survey. Krishnamurthy et al. (2014) finds a low willingness to pay (WTP) that corresponds to 11-12% of current electric bill and ambiguous effect of income. By the same way, Shi et al. (2013) find that economic variables are less important, while environmental concern or attitude consistently drives the decision to enter the hypothetical market of green electricity and membership in environmental organizations has effects on the WTP.

In the literature, there are less studies that investigate the real behaviour of consumers towards the renewable energy adoption relying on real survey than hypothetical consumer's behaviour. A survey that relies on the real behaviour of consumers can help to investigate how consumers actually react according to different financing mechanisms for green electricity. Roe et al. (2001) find that hypothetical analysis based on the WTP and hedonic analysis of actual price premiums charged for green electricity give similar values for key environmental attributes. Some studies only focus on green consumers (Young et al., 2010) and can suffer from selection bias because policy recommendations could not be extended to consumers who do not adopt green behaviours. There are also disparities in the effect of different financing mechanisms for green electricity. For instance, Kotchen and Moore (2007) consider the voluntary contribution mechanism (VCM) and the green tariff mechanism (GTM) to finance a new generation capacity. They find that the two financing mechanisms are not equivalent when the constraint related to the level of contribution is binding. Arkesteijn and Oerlemans (2005) investigate factors that influence the early adoption of green electricity by Dutch residential users combining cognitive and economic approach. They find that additionally to economic variables, variables that are related to cognitive, basic knowledge and to actual environmental behaviour in the past, strongly predict the probability of the early adoption of green electricity.

Variables that affect green demand in the residential sector can also affect the household's decision to investment in energy efficiency. We provide some literature on factors that influence investment's decision in energy efficiency in residential sector in the following section.

2.2 Literature review on investment in energy efficiency and household behaviour

There is a substantial literature on how the household's behaviours affect adoption and investment in energy efficiency. Energy efficiency is relatively cheap way to reduce green house gas emissions in the short and medium term horizons (Dietz et al., 2009; and Vandenbergh et al., 2008), while in a long term a complete transition to a low carbon economy is likely to be very slow (Fouquet, 2010). There is a large evidence that economic factors are motivations for energy efficiency (Howarth, 1997; Kempton and Neiman, 1986; and Steg, 2008) and can be helpful in designing appropriate taxes or subsidies mechanism to promote energy saving actions. For instance, saving money or reducing energy bill can be incentives to investment in energy efficiency. However, the potential gain from reducing energy use can be hindered by some problems such as split incentives, uncertainty about the gain, moral hazard problem that may refrain households from adopting or investing in an energy conservation system. Reducing energy use can also lead to reverse effects such as rebound effect or take-back effect (Greening et al., 2000; and Urban and Scasny, 2012). The rebound effect can be solved by capturing efficiency gains for reinvestment in natural capital rehabilitation (Wackernagel and Rees, 1997) or in supporting environmental actions through donation (Bindewald, 2013). Alternatively, the rebound effect can also be solved by pro-environmental motivation (Urban and Scasny, 2012).

But in the literature on energy-saving behaviour, there is a no evidence of the effect of pro-environmental motivation on energy-saving actions at household level. The early literature found that environmental concern does not have any effect on both energy consumption and energy-saving actions (Heslop et al., 1981). However, there has been growing concern about climate change in recent years (Capstick et al., 2015) and many studies recently find significant effects of environmental concerns on energy-saving actions (Barr et al., 2005; and Whitmarsh and O'Neill, 2010). Some few studies still support limited effect (Carlsson-Kanyama et al., 2005; and Whillans et al., 2015) or no effect (Steg et al., 2011) of pro-environmental motivation. Both economic and environmental concerns have different effects when we distinguish the actions of investing in energy efficiency.

The two main types of energy conservation actions are efficiency investment and curtailments (Jansson et al., 2009). The former involves the acquisition of new technologies, low-energy appliances (Top-rated energy-efficient appliances, low-energy light bulbs, energy-efficient windows, etc.) or energy efficient systems (automated control systems, domotic or home automation), that needs monetary investment. The latter refers to non-monetary investments that are behaviour changes such that scheduling efforts, turning off lights, cutting down on heating or on air conditioning and switching off standby mode. For instance monetary efficiency investments that rely on external conditions (Urban and Scasny, 2012) such as economic concerns, are less affected by internal motivations (Guagnano et al., 1995) such as pro-environmental motivations. While, Black et al. (1985) finds the opposite effect on non-monetary efficiency investments. But in the end, both economic and environmental concern should have significant effects on energy-saving actions that are the outcome of both monetary and non-monetary investments. Additionally to socio-economic and demographic factors, Urban and Scasny (2012) investigate in a multi-country setting using EPIC-OECD data how environmental concern affects the adoption of monetary and non-monetary investments in energy efficiency. They find a positive and significant effect for pro-environmental motivation and mixed effect for the other variables.

The different variables that affect the renewable energy adoption decision of household also have significant effects on energy efficiency investments as well. The fact that studies mostly focus on either renewable energy adoption of energy efficiency investment may explain empirical disparities in the effect of economics and environmental concerns. Interestingly enough, if the two decisions are interrelated, it cannot be estimated independently. In this case, univariate methods that estimate separately the two decisions of renewable adoption and energy efficiency potentially produce biased results because it may exist unobserved characteristics that determine both decisions. For instance, household that is pro-environmental can find it unnecessary to invest in renewable energy (resp in energy efficiency) if he has already invested in energy efficiency (resp renewable energy). In this case, despite his pro-environmental motivation, he will not adopt renewable energy (resp energy efficiency). By the same way, household that already invests in energy efficiency (resp renewable energy) may have limited financial capacity to additionally invest in renewable energy (resp energy efficiency). Then, by jointly analysing the two possible decisions of the adoption of renewable energy and investments in energy efficiency taken by the household, one can capture the interrelation and the interaction between them. Such investigation has potential gain for policy implications as both adoption of renewable energy and investments in energy efficiency are important in the future world energy market (Sheffield, 1997) and in the energy transition. To our knowledge, there is no such investigation in economics literature and our study aims at filling this gap in literature.

3 Data and Method

3.1 Data

We use the two rounds large-scale household surveys of Environmental Policy and Individual Beharviours changes (EPIC) that were conducted by the Organisation for Economic Cooperation and Development (OECD). The two rounds focus on five thematic areas (energy, food, transport, waste and water) and aim at understanding household's reactions to different environmental policies, the interactions of these policies and the role of household's attitudes towards environment (Serret and Brown, 2014). Information were collected on household's characteristics (age, income, education), their environmental attitudes (environmental concerns) using an internet-based questionnaire.

The first round of EPIC survey was carried out in January-February 2008 in ten OECD countries (Australia, Canada, France, Korea, Netherlands, Sweden, Czech Republic, Italy, Norway and Mexico.). The sample size was approximately 1,000 households in each country for a total of 10,000 households. In 2011, the same survey was carried out in six same countries as in 2008 (Australia, Canada, France, Korea, Netherlands and Sweden) and in five additional countries (Chile, Japan, Spain, Israel and Switzerland.). As in the first round, approximately 1,000 households were interviewed for a total of 12,200 households. The dataset of the 2011 EPIC survey is richer than that of 2008 because it includes additional news areas such as eco-innovation, knowledge, policy preferences and country-specific questions. Unfortunately, we could not use this additional information in this paper because we intend to compare both datasets. Then, we need to use the same information on the household's behaviour over the two rounds surveys. As the same respondent cannot be identified in the EPIC survey from 2008 to 2011, we decide to pool the two datasets for the six countries that were surveyed in 2008 and in 2011 and to control for the effect of year. Note that efforts are made to avoid sample bias through stratification (age, gender, etc.) and quota sampling with a large geographical coverage [1]. Also, the two rounds are independent surveys and each represents a random sample from the population. Then, there is no correlation in the error terms within the observations of each survey.

We use data from the energy section (Part E) that we combine with socio-demographic characteristics (Part A), Attitudinal characteristics (Part B). More precisely, in the energy section we mainly focus on questions that concern the adoption of renewable energy (solar panels, wind turbines, hydro, etc.), non-monetary investments (turn off lights when leaving a room, cut down on heating or air conditioning, turn off appliances when not in use, switch off standby mode of appliances or electronic devices, etc.) and monetary investments (Energy-efficiency-rated appliances, low-energy light bulbs, etc.) in energy efficiency. Both independent and dependent variables that are used in this paper are described in the following section (section 3.2).

3.2 Description of variables

The dependent variables are constructed from questions related to renewable energy adoption and investments in energy efficiency. In the two rounds surveys, a question was asked and identifies households that installed over the past ten years in their current primary residence, a renewable energy (Solar panels for electricity or hot water and Wind

[1]For more details, see OECD (2011, 2014).

turbines). Households can answer that they installed renewable energy items or that the residence was already equipped. As we focus on the use of the renewable energy, we consider both answers as renewable energy adoption. We cross the information on the installation of renewable energy items with the source of electricity that the residence uses. We consider that the household stating that the energy from electricity provider is already from renewable energy sources (2008) or that they have chosen the "renewable or green" energy tariff from their electricity provider (2011), was adopted renewable energy as well. Additionally, the 2011 survey provides a refinement giving some information on household that uses thermal solar panel for water heating, who is considered as having adopted renewable energy as well.

The EPIC surveys provide information on monetary investment in energy efficiency such as: top-rated energy-efficient appliances, low-energy light bulbs, energy-efficient windows, thermal insulation of walls or roof, etc.). Households were asked whether or not they installed energy efficiency items over the past ten years in their current primary residence. As before, we consider own installed items and already installed items as adoption of energy efficiency items to reduce the use of energy. The EPIC surveys also provide information on behaviour changes to reduce the use of energy that we call non-monetary investments in energy efficiency. Households were asked how often in their daily life, they adopt behaviours that could help to reduce their energy use such as: cutting down on heating or air conditioning, switching off standby mode of appliances or electronic devices (TV, computer), air dry laundry rather than using a clothes dryer, etc. Whether the household invests in energy efficiency by using a part of his income or makes efforts to reduce his consumption of energy towards behaviours changes, in the end he reduces his consumption of energy. Therefore, we consider both non-monetary and monetary investments as energy efficiency adoption.

There is no evidence in the literature about the importance of either socio-economic and residence variables or attitudinal and perception variables in the decision of household to adopt renewable energy or to invest in energy efficiency. We decide to include in our independent variables, variables that are available in the two EPIC datasets and are also useful for policy recommendations. We consider four categories of characteristics. First, we use socio-economic variables such as gender, age, income, area of residence, etc. Second, we consider perception, vote in elections, trust and commitment in any local, charitable or environmental organization as attitudinal variables. Some variables are also related to the energy use: individual metering, peak price of electricity, factors that encourage to reduce energy consumption, etc. Finally, we control for the year. The full description of the independent variables that are used and the summary statistics are presented in appendix 1.

3.3 Method

We use the two rounds surveys of EPIC in 2008 and in 2011 and then decide to drop countries that were not surveyed in both 2008 and 2011. Our analysis focus on the following six countries: Australia, Canada, France, Korea, Netherlands and Sweden. The two rounds are independent surveys and each represents a random sample from the population. Then, there is no correlation in the error terms within the observations of each survey. Moreover, as the same respond cannot be identified in the EPIC survey from 2008 to 2011, we decide to pool the two datasets for the six countries and to control for the effect of time.

The household faces two different decisions that contribute to energy transition. He can decide whether to invest or not in renewable energy. He can also decide whether or not to invest in energy efficiency. Then, the household has two simultaneous decisions that could be related. For instance, household may financially be constrained to invest in energy efficiency (resp renewable energy) if he invests in renewable energy (resp energy efficiency). Also, the household that is pro-environmental may decide not to make additional effort to invest in renewable energy (resp in energy efficiency) if he has already invested in energy efficiency (resp renewable energy). Although the two decisions do not directly depend on each other, their errors terms may be correlated. Following, Cameron and Trivedi (2010), we first use bivariate probit model that accounts for the joint decisions based on their correlation and provide more-efficient estimator. Note that the probit model assumes that unobservable variables and residuals are normally distributed and independent of the explanatory variables. From the bivariate probit model, we are only able to provide the joint probabilities, but not their determinants. Thus, we additionally use the ordered probit model to account for the interaction between the two decisions. More precisely, we focus on factors that affect the joint probability of adopting renewable energy and investing in energy efficiency and that of doing nothing by using ordered probit model. In fact, we intend to explain why some households decide to invest both in energy efficiency and in renewable energy, while others decide to only invest in renewable energy or to only invest in energy efficiency or to do nothing. Then, the household that only adopts renewable energy or only reduces his energy consumption contribute to the energy transition better than the household who does nothing and less than the one who jointly adopts renewable energy and invests in energy efficiency. In this case, the ordered probit model is appropriate because the outcomes can be ranked.

4 Joint decision of renewable energy adoption and investment in energy efficiency.

Table 1 below displays the cross repartition of the two decisions of renewable adoption and investment in energy efficiency.

According to table 1, 97.9% of the sample invest in energy efficiency. Then, a large majority of household undertake non-monetary investments, monetary investments or both in energy efficiency. In contrast, only 13.2% adopt renewable energy by installing their own solar panel or wind turbines or by subscribing to green energy from the electricity provider. Cross analysis shows that among those who invest in energy efficiency, only 13.2% of households additionally adopt renewable. There are 2% of households who decide neither to adopt renewable energy, nor to invest in energy efficiency. Finally, very few households in the sample adopt renewable energy without investing in energy

Table 1: **Investment in energy efficiency by adoption of renewable energy**

	Adoption of renewable energy		
Investment in energy efficiency	no	yes	Total
no	263	5	268
yes	10,910	1,698	12,608
Total	11,173	1,703	12,876

efficiency. There are then good reasons to believe that the two decisions may be correlated. To check this, we provide the correlation between the decision to adopt renewable energy and that of investing in energy efficiency.

Table 2: Cross-correlation table

Variables	Adoption of re energy	Investment in ee
Adoption of re	1.000	
Investment in ee	0.049	1.000

The correlation coefficient of 0.049 is positive and different from zero. Following, Cameron and Trivedi (2010), we use bivariate probit model that accounts for the joint decisions based on their correlation and provide more-efficient estimator. The result from the bivariate probit provides the test of the null hypothesis that the true correlation coefficient is equal to 0 and justifies the importance of using bivariate probit model instead of estimating the two decisions separately. Our results reject the null hypothesis of the correlation coefficient at 1% (Prob>chi2=0.0002). Then, bivariate probit model is more appropriate than separate univariate probit models because the two decisions are interrelated and cannot be estimated independently. As a result, univariate methods that estimate separately the two decisions of renewable adoption and energy efficiency potentially produce biased results because it may exist unobserved characteristics that determine both decisions. We also perform the goodness of fit and prediction test in order to evaluate how well the model fits the observations. We then compare the predicted probability that is summarized in table 3 below with the frequency of the sample in table 1. We find that the predicted probability is close to the frequency of the sample.

Table 3: Summary statistics

Variable	**Mean**	**Std. Dev.**	**N**
biprob1	0.1442713	0.059	10719
biprob2	0.9853786	0.021	8273
biprob00	0.0142184	0.021	8273
biprob01	0.8385394	0.056	8273
biprob10	0.000403	0.001	8273
biprob11	0.1468393	0.059	8273

We can now turn to the interpretation of the results of the bivariate probit model that are presented in table 6. We first focus on the decision of the household to adopt or not the renewable energy. The results show that adoption of renewable energy is significantly effected by home ownership, environmental concerns, commitment in environmental and local organization, trust in local authorities and in manufacturers taking into account energy cost before renting or buying a house and year of survey at 1% level. While gender and size of household have significant effects on renewable adoption at 5% and 10%, respectively. The fact that the household owns the residence increase their probability to adopt renewable energy. This is intuitive in the sense that investment in solar panels or wind turbine is costly is profitable after many years of use. Then, the tenant will not have incentives to undertake such investments even if he plans to stay a long time. As a result, the duration in the residence is not significant. The size of the household has a positive effect on the probability to adopt renewable energy. As sometime, the size of household can be used as a proxy of the household income, this positive effect can be explained by financial constraints. Household with high size potentially detains financial capacity and is then more likely to invest in renewable energy. Moreover, male having primary purchasing responsibility are more favourable to renewable adoption than female. This can be justified by the fact that male often gains the highest income in the household. However, the results show that the total income of the household does not have any significant impact on the adoption of renewable energy. Even if installation of wind turbine or solar turbines can be more favourable out of urban area, the area of residence has no significant effects on renewable adoption. The fact that the household lives in rural or urban area does not significantly affect its decisions to adopt renewable energy or not. In fact, installing solar panels or wind turbines has the same cost in rural as in urban area.

Among the perception variables, only environmental concern has significant effect of renewable energy adoption. The decision of households to adopt renewable energy is significantly and positively sensitive to environmental concerns in general (waste, air pollution, climate change, etc.) than specific environmental issues. By the same way, commitment in environmental and local organizations significantly and positively affect renewable energy adoption. People who trust local authorities and manufacturers are more likely to invest in renewable energy, while trust in scientists and in Non Governmental Organization (NGO) do not significantly affect the adoption of clean energy. People who take energy costs into account when purchasing or renting their primary residence are more likely to adopt renewable energy. Finally, the probability of adopting renewable energy significantly increases with year. In fact, as the awareness of energy-related environmental issues increases over years, people are more sensitive to the type of energy they use and are then more likely to adopt renewable energy.

The decision of the household to invest in energy efficiency significantly depends on age, climate change, waste generation concerns and individual metering at 1%. Also, ownership of the residence, participation in local vote, commitment in local organization, year and the importance of energy efficiency labels in the reduction of energy consumption are significant at a level of 5%. Finally, the resource depletion concerns, commitment in charitable organization and the importance of less expensive energy-efficient equipment in the reduction of energy consumption are significant at a level of 10%. Only the ownership of the residence and commitment in local organization have positive and significant effect on both decisions of renewable adoption and investment in energy efficiency. Contrary to the decisions of renewable adoption, neither income nor the size of the household has significant effect on the decision of the household to invest in energy efficiency. By the same way, investment in energy efficiency significantly depends on specific environmental concerns such as climate change, resource depletion and waste generation than general environmental issues. People who are more sensitive to climate change concerns are more likely to reduce their consumption of energy as well as those who are less sensitive to resource depletion and waste generation. As energy mostly contribute to climate change, its negative consequences are then important rationale to reduce energy consumption. Participation in local vote, commitment in local organization as well as in charitable organization have positive and significant effects on the behaviour of the household to reduce their consumption of energy, while commitment in environmental organization has no significant effect. Trusting information on environmental issues from any sources does not significantly affect the decision of household to reduce their energy use. Then households do not prioritize a specific source of information in their decision to invest in energy efficiency.

Additionally, we consider specific characteristics that could affect the adoption of energy-efficient equipments and behaviour changes. The household who pays according to his real energy consumption through individual metering, is more likely to either undertake monetary or non-monetary investments to reduce his energy consumption and to reduce his energy cost. While peak tariff system does not significantly affect energy efficiency decision. People who find that less expensive energy-efficient equipment and energy efficiency labels are important to reduce their energy consumption are more likely to invest in energy efficiency, while those who find that information on energy conservation measures and environmental benefits are important do not significantly change their decisions. As before, due to the increase in the awareness of energy-related environmental issues over years, people are more sensitive to their consumption of energy and are then more likely to invest in energy efficiency. The marginal effects of the bivariate probit model are presented in appendix 3.

5 Interaction between renewable energy adoption and investment in energy efficiency.

As the bivariate probit model could not provide us the determinants of the joint probabilities, we additionally use the ordered probit model. In this section, we are interested in the interaction between the two decisions of adopting renewable energy and of investing in energy efficiency. Basically, we intend to explain why some households decide both to invest in energy efficiency and also to invest in renewable energy, while others decide to only invest in renewable energy or to only invest in energy efficiency or to do nothing. As a result, the household has four possible choices. He can decide (i) both to reduce the energy use and to invest in RE, (ii) to only invest in RE, (iii) to only reduce its own energy consumption or (iv) do nothing. In fact, it is difficult to rank the two decisions of only adoption of renewable energy or only reduction of energy consumption. Also, Table 1 shows that only very few households (0.04%) adopt only renewable energy without investing in energy efficiency. Then, we combine the two outcomes. The implication is that the household that only adopts renewable energy or only reduces his energy consumption contribute to the energy transition better than the household who does nothing and less than the one who jointly adopts renewable energy and invests in energy efficiency. The outcome variable can then take three different values: 2 for both adoption of renewable energy and investment in energy efficiency, 1 for adoption of renewable energy or investment in energy efficiency and 0 for none of them. Before going into details of the estimation results, we perform the goodness of fit and prediction test in order to evaluate the fit of the ordered probit model. As before, the frequency of the sample in table 4 is compared with the predicted probability summarized in table 5. We find that the two results are close to each other.

Table 4:

stats	**reee00**	**reee01/reee10**	**reee11**
Percent	.0204	.8477	.1319

Table 5:

stats	**p0oprobit**	**p1oprobit**	**p2oprobitt**
mean	.014156	.8388463	.1469977

The results of the ordered probit model show that ownership of primary residence, environmental concerns, commitment in environmental and local organizations, peak tariff, year and taking into account energy cost before renting or buying a house significantly affect the joint probabilities of adopting renewable energy and investing in energy efficiency at 1%. The joint decisions also significantly depends on climate change concerns and trust in local authorities at 5%, while it only significantly depends on trust in manufacturers, size of household and age at 10%. Despite the fact that age (gender resp.) has significant effect on investment in energy efficiency (adoption of renewable energy resp.) and no significant effect on adoption of renewable energy (investment in energy efficiency resp.), gender has no effect on the joint decisions while age has a positive effect. Then, the older is the respondent, the higher is the probability to adopt renewable energy and to invest in energy efficiency and the lower is the probability to do nothing. As in the bivariate model, employment status, area of residence, duration of living in the primary residence and income have no significant effects on the joint outcomes. Environmental concerns as well as specific issue such as climate change concerns and commitment in both local and environmental organizations significantly increase the probability to adopt renewable energy and to invest in energy efficiency and significantly decrease the probability to do nothing. Other special issues such as air pollution, resource depletion and waste generation, participation in local vote and in charitable organization do not have significant effects.

Only trust in local authorities and in manufacturers have the same positive and significant effects on the joint outcomes and on the separate decision of adopting renewable energy. People who take into account energy cost before renting or buying a house are more likely to adopt renewable energy and invest in energy efficiency, and less likely to do nothing. Contrary to the separate decision of investing in energy efficiency, peak tariff has a significant and positive effect on the joint outcomes, while individual metering has no significant effect. Any of the factors that could encourage the household to reduce their energy consumption does not have significant effects on the decision to adopt renewable energy and invest in energy efficiency or to do nothing. The results of the bivariate probit model and the ordered probit model are summarized in the table 6, while the marginal effects of the ordered probit model are summarized in appendix 3.

6 Conclusion

This paper uses the two rounds survey (2008 and 2011) on Environmental Policy and Individual Behaviour Change (EPIC) from the Organisation for Economic Co-operation and Development (OECD) and pools the two datasets from the six countries that were surveyed in the two rounds (Australia, Canada, France, Korea, Netherlands and Sweden). The paper fills the gap in literature by first showing that the two decisions of adopting renewable energy and of investing in energy efficiency are interrelated and cannot be estimated independently. As a result, univariate methods that estimate separately the two decisions of renewable adoption and energy efficiency potentially produce biased results because it may exist unobserved characteristics that determine both decisions. Second, the paper investigates characteristics of the household that significantly affect the interaction between the two decisions by using ordered probit model. More precisely, the paper provides evidence on factors that affect the joint probability of adopting renewable energy and investing in energy efficiency and the probability of doing nothing. The results show that ownership of primary residence, environmental concerns, commitment in environmental and local organizations, peak tariff, year and taking into account energy cost before renting or buying a house significantly affect the joint probabilities of adopting renewable energy and investing in energy efficiency at 1%. The joint decisions also significantly depends on climate change concerns and trust in local authorities at 5%, while it only significantly depends on trust in manufacturers, size of household and age at 10%. This contribution can serve to define incentives policies to boost energy transition.

Table 6: Bivariate Probit and ordered Probit models

Variables	Bivariate probit model		Ordered Probit model
	re adoption	investment in ee	
Socio-demographics variables			
age of the respondent	.0011162	.0091061*	.0027336***
sex of the respondent	.0578034***	-.0329275	.0519251
employment status	-.0184523	.001368	-.0039953
income of household	-.0002113	.0013812	-.0000565
Size of household	.0348583**	.0009641	.0266065***
Owner	.2087816*	.1810359**	.2032576*
Urban	.0317851	-.1005507	.0336728
duration	-.0231515	-.0069379	-.0231914
Attitudinal variables			
Perception			
Environmental concerns (general issues)	-.0358639*	-.0288888	-.0356256*
Air pollution issues	.0066242	-.0265662	.0071011
Climate change issues	-.02938	-.1781573*	-.0604092**
Resource depletion issues	-.0171316	.1169351***	-.0001566
Waste generation issues	-.0258895	.1743338*	.0116592
Commitment			
Participation in local vote	.0170358	.187161**	.0434549
Commitment in charitable organization	.0333311	.2064198***	.0455289
Commitment in environmental organization	.2748837*	.102953	.2446574*
Commitment in local organization	.1505407*	.3788127**	.1502575*
Trust			
Trust in scientists	.0047241	.0053014	.0082987
Trust in local authorities	.0404258*	-.0157131	.0332323**
Trust in manufacturers	.0503611*	-.0423573	.0286752***
Trust in NGOs	-.0110196	.0008463	-.0060628
Energy use variables			
Individual metering	NA	.3854757*	.0956948
Peak Tariff	NA	.0656722	.2374244*
Energy costs before buying or renting a house	.1906616*	.0855035	.1752376*
Importance of information to reduce energy use	NA	.0453089	-.0146265
Importance of environmental benefits to reduce energy	NA	-.0090642	.0781338
Importance of label to reduce energy use	NA	.3004197**	.0675574
Importance of less expensive ee to reduce energy use	NA	.2357317***	.0595985
Other			
Year of the survey	.1504981*	.2709371**	.1938598*
cons	-1.459394*	.5694912	NA

*** 1%, ** 5% and *** 10%; rho=.2952796 and Prob > chi2 = 0.0002.**

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8 Appendices

Appendice 1: Description and summary of independent variables.

Variables	Description	Mean
Socio-demographics variables		
Age of the respondent	Continuous variable	43.42651
Sex of the respondent	0 for Female and 1 for Male	.4859849
Employment status	0 for not working and 1 for working	.600778
Income of household	1 for usd 1- usd 24200….up to 10 for more than usd 127000	9.012001
Size of household	1 for 1… up to 5 for 5+	2.711235
Owner	0 for no owner and 1 for owner	.6130911
Urban	0 for not living in urban area and 1 for living in urban area	.6971815
Duration	1 for less than 2 years… up to 5 for more than 15 years	2.497554
Attitudinal variables		
Perception		
Environmental concerns (general issues)	1 for most important... up to 6 for least	3.487771
Air pollution issues	1 for most important... up to 6 for least	3.366204
Climate change issues	1 for most important... up to 6 for least	3.284063
Resource depletion issues	1 for most important... up to 6 for least	3.403802
Waste generation issues	1 for most important... up to 6 for least	3.250335
Commitment		
Participation in local vote	0 for no and 1 for yes	.669229
Commitment in charitable organization	0 for no and 1 for yes	.2370526
Commitment in environmental organization	0 for no and 1 for yes	.1372777
Commitment in local organization	0 for no and 1 for yes	.1399953
Trust		
Trust in scientists	1 for least truthworthy... up to 5 for most	3.76088
Trust in local authorities	1 for least truthworthy... up to 5 for most	2.673404
Trust in manufacturers	1 for least truthworthy... up to 5 for most	2.334171
Trust in NGOs	1 for least truthworthy... up to 5 for most	3.449405
Energy use variables		
Individual metering	0 for no and 1 for yes	.9422196
Peak Tariff	0 for no and 1 for yes	.5028133
Energy costs before buying or renting a house	0 for no and 1 for yes	.3090032
Importance of information to reduce energy use	0 for no and 1 for yes	.862567
Importance of environmental benefits to reduce energy	0 for no and 1 for yes	.8657504
Importance of label to reduce energy use	0 for no and 1 for yes	.8701763
Importance of less expensive ee to reduce energy use	0 for no and 1 for yes	.8789502
Other		
Year of the survey	0 for 2008 and 1 for 2011	.5259725

```
Seemingly unrelated bivariate probit            Number of obs   =       8273
                                                Wald chi2(52)   =     348.90
Log likelihood =  -3891.872                     Prob > chi2     =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
re						
age	.0011162	.0015056	0.74	0.458	-.0018347	.0040671
sex	.0578034	.0346976	1.67	0.096	-.0102027	.1258095
employme	-.0184523	.0369505	-0.50	0.618	-.0908739	.0539694
income	-.0002113	.0012059	-0.18	0.861	-.0025748	.0021523
size_hh	.0348583	.0150048	2.32	0.020	.0054495	.0642671
owner	.2087816	.0400449	5.21	0.000	.130295	.2872683
urban	.0317851	.0378474	0.84	0.401	-.0423944	.1059646
duration	-.0231515	.0187769	-1.23	0.218	-.0599535	.0136504
env_conc	-.0358639	.0114477	-3.13	0.002	-.0583009	-.0134268
air_poll	.0066242	.0347015	0.19	0.849	-.0613895	.0746379
climate_	-.02938	.0292692	-1.00	0.315	-.0867466	.0279866
resource	-.0171316	.0320934	-0.53	0.593	-.0800335	.0457703
waste_ge	-.0258895	.0310824	-0.83	0.405	-.08681	.035031
vote_loc	.0170358	.0402624	0.42	0.672	-.061877	.0959486
com_char	.0333311	.0411302	0.81	0.418	-.0472827	.1139449
com_env	.2748837	.0487562	5.64	0.000	.1793233	.370444
com_loca	.1505407	.0469534	3.21	0.001	.0585137	.2425677
trust_lo	.0404258	.0154418	2.62	0.009	.0101605	.0706911
trust_sc	.0047241	.0167245	0.28	0.778	-.0280553	.0375036
trust_ma	.0503611	.0162267	3.10	0.002	.0185573	.082165
trust_NG	-.0110196	.0162319	-0.68	0.497	-.0428336	.0207944
exante	.1906616	.0366257	5.21	0.000	.1188766	.2624467
year	.1504981	.0522935	2.88	0.004	.0480047	.2529914
_cons	-1.459394	.1701271	-8.58	0.000	-1.792837	-1.125951
ee						
age	.0091061	.0033596	2.71	0.007	.0025215	.0156908
sex	-.0329275	.0780932	-0.42	0.673	-.1859874	.1201325
employme	.001368	.0814099	0.02	0.987	-.1581925	.1609285
income	.0013812	.0025027	0.55	0.581	-.003524	.0062864
size_hh	.0009641	.0325808	0.03	0.976	-.0628931	.0648213
owner	.1810359	.0843853	2.15	0.032	.0156438	.3464281
urban	-.1005507	.093106	-1.08	0.280	-.2830352	.0819338
duration	-.0069379	.0425055	-0.16	0.870	-.0902471	.0763712
env_conc	-.0288888	.0262355	-1.10	0.271	-.0803093	.0225318
air_poll	-.0265662	.0726682	-0.37	0.715	-.1689933	.1158609
climate_	-.1781573	.0651546	-2.73	0.006	-.305858	-.0504566
resource	.1169351	.0661048	1.77	0.077	-.012628	.2464982
waste_ge	.1743338	.0632812	2.75	0.006	.050305	.2983626
vote_loc	.187161	.0809231	2.31	0.021	.0285545	.3457674
com_char	.2064198	.1177211	1.75	0.080	-.0243093	.4371489
com_env	.102953	.13365	0.77	0.441	-.1589962	.3649022
com_loca	.3788127	.1754654	2.16	0.031	.0349068	.7227186
ind_mete	.3854757	.1453523	2.65	0.008	.1005904	.6703611
peak	.0656722	.0801541	0.82	0.413	-.0914271	.2227714
exante	.0855035	.0903087	0.95	0.344	-.0914984	.2625053
trust_sc	.0053014	.0354646	0.15	0.881	-.0642079	.0748107
trust_lo	-.0157131	.0327324	-0.48	0.631	-.0798674	.0484411
trust_ma	-.0423573	.035047	-1.21	0.227	-.1110482	.0263336
trust_NG	.0008463	.034129	0.02	0.980	-.0660452	.0677379
est_info	.0453089	.1153952	0.39	0.695	-.1808617	.2714794
est_env	-.0090642	.1200106	-0.08	0.940	-.2442806	.2261522
est_labe	.3004197	.1185414	2.53	0.011	.0680829	.5327566
est_lexp	.2357317	.1242824	1.90	0.058	-.0078573	.4793208
year	.2709371	.1255664	2.16	0.031	.0248315	.5170428
_cons	.5694912	.3815503	1.49	0.136	-.1783338	1.317316
/athrho	.3043404	.0892985	3.41	0.001	.1293185	.4793623
rho	.2952796	.0815126			.1286024	.4457328

```
Likelihood-ratio test of rho=0:     chi2(1) =  13.9925    Prob > chi2 = 0.0002
```

Ordered probit regression

	Number of obs	=	**8273**
	LR chi2(**29**)	=	**330.53**
	Prob > chi2	=	**0.0000**
Log likelihood = **-3886.2473**	Pseudo R2	=	**0.0408**

reee	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	.0027336	.0014006	1.95	0.051	-.0000115	.0054786
sex	.0519251	.0321281	1.62	0.106	-.0110448	.114895
employme	-.0039953	.0341333	-0.12	0.907	-.0708955	.0629048
income	-.0000565	.0010751	-0.05	0.958	-.0021636	.0020507
size_hh	.0266065	.0139058	1.91	0.056	-.0006483	.0538612
owner	.2032576	.0367571	5.53	0.000	.1312149	.2753003
urban	.0336728	.0352179	0.96	0.339	-.0353531	.1026987
duration	-.0231914	.0173713	-1.34	0.182	-.0572386	.0108558
env_conc	-.0356256	.0106289	-3.35	0.001	-.0564578	-.0147934
air_poll	.0071011	.0319736	0.22	0.824	-.055566	.0697682
climate_	-.0604092	.0270585	-2.23	0.026	-.1134429	-.0073756
resource	-.0001566	.0295433	-0.01	0.996	-.0580604	.0577472
waste_ge	.0116592	.0286232	0.41	0.684	-.0444412	.0677596
vote_loc	.0434549	.0369901	1.17	0.240	-.0290443	.1159542
com_char	.0455289	.0385336	1.18	0.237	-.0299955	.1210533
com_env	.2446574	.0464104	5.27	0.000	.1536947	.33562
com_loca	.1502575	.0446963	3.36	0.001	.0626544	.2378606
trust_lo	.0332323	.0142338	2.33	0.020	.0053346	.0611301
trust_sc	.0082987	.0154443	0.54	0.591	-.0219715	.038569
trust_ma	.0286752	.0150483	1.91	0.057	-.0008189	.0581693
trust_NG	-.0060628	.0149398	-0.41	0.685	-.0353441	.0232186
exante	.1752376	.0344975	5.08	0.000	.1076238	.2428515
ind_mete	.0956948	.0897373	1.07	0.286	-.080187	.2715767
peak	.2374244	.0326303	7.28	0.000	.1734702	.3013786
est_info	-.0146265	.0567959	-0.26	0.797	-.1259444	.0966913
est_env	.0781338	.0605453	1.29	0.197	-.0405328	.1968004
est_labe	.0675574	.0618378	1.09	0.275	-.0536424	.1887572
est_lexp	.0595985	.0617828	0.96	0.335	-.0614936	.1806906
year	.1938598	.0498473	3.89	0.000	.0961608	.2915588
/cut1	-1.395262	.1780305			-1.744195	-1.046329
/cut2	1.979761	.1788369			1.629247	2.330275

Marginal effects on Pr(re=0,ee=0)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-.0001954	.0000723	-2.70	0.007	-.0003372	-.0000536
sex	.0006767	.0016729	0.40	0.686	-.002602	.0039555
employme	-.0000204	.0017428	-0.01	0.991	-.0034363	.0033955
income	-.0000295	.0000535	-0.55	0.582	-.0001344	.0000755
size_hh	-.0000374	.000698	-0.05	0.957	-.0014055	.0013306
owner	-.0039744	.0018123	-2.19	0.028	-.0075265	-.0004223
urban	.0021363	.0019892	1.07	0.283	-.0017625	.006035
duration	.0001596	.0009099	0.18	0.861	-.0016237	.0019429
env_conc	.0006354	.000562	1.13	0.258	-.000466	.0017369
air_poll	.0005653	.0015558	0.36	0.716	-.002484	.0036145
climate_	.0038264	.0014081	2.72	0.007	.0010665	.0065863
resource	-.0024939	.0014158	-1.76	0.078	-.0052688	.0002809
waste_ge	-.0037179	.0013866	-2.68	0.007	-.0064356	-.0010002
vote_loc	-.0040131	.0017471	-2.30	0.022	-.0074373	-.0005889
com_char	-.004433	.0024901	-1.78	0.075	-.0093136	.0004476
com_env	-.0023354	.0028594	-0.82	0.414	-.0079398	.003269
com_loca	-.0081784	.0036067	-2.27	0.023	-.0152473	-.0011094
trust_lo	.0003168	.0007011	0.45	0.651	-.0010573	.0016908
trust_sc	-.0001157	.0007592	-0.15	0.879	-.0016037	.0013723
trust_ma	.0008821	.0007502	1.18	0.240	-.0005882	.0023524
trust_NG	-.0000128	.0007306	-0.02	0.986	-.0014447	.0014191
exante	-.0019214	.0019357	-0.99	0.321	-.0057154	.0018725
year	-.00587	.0026892	-2.18	0.029	-.0111407	-.0005993
ind_mete	-.0082484	.003205	-2.57	0.010	-.01453	-.0019668
peak	-.0014053	.001712	-0.82	0.412	-.0047607	.0019502
est_info	-.0009695	.0024719	-0.39	0.695	-.0058144	.0038753
est_env	.000194	.002568	0.08	0.940	-.0048392	.0052271
est_labe	-.0064284	.0025838	-2.49	0.013	-.0114925	-.0013643
est_lexp	-.0050442	.0026862	-1.88	0.060	-.010309	.0002206

Marginal effects on Pr(re=0,ee=1)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-.0000526	.0003391	-0.16	0.877	-.0007173	.0006121
sex	-.0135235	.0078163	-1.73	0.084	-.0288431	.0017961
employme	.0041213	.0083182	0.50	0.620	-.012182	.0204247
income	.0000764	.0002709	0.28	0.778	-.0004546	.0006075
size_hh	-.0077097	.0033744	-2.28	0.022	-.0143234	-.0010959
owner	-.0424251	.0089747	-4.73	0.000	-.0600152	-.024835
urban	-.009201	.0085644	-1.07	0.283	-.025987	.0075849
duration	.0049857	.0042313	1.18	0.239	-.0033075	.0132788
env_conc	.0073349	.0025796	2.84	0.004	.002279	.0123908
air_poll	-.0020376	.0077956	-0.26	0.794	-.0173167	.0132414
climate_	.002702	.0065955	0.41	0.682	-.010225	.015629
resource	.0063021	.007204	0.87	0.382	-.0078175	.0204217
waste_ge	.0094729	.0069812	1.36	0.175	-.00421	.0231558
vote_loc	.0002282	.0090324	0.03	0.980	-.017475	.0179315
com_char	-.0029732	.0093873	-0.32	0.751	-.021372	.0154256
com_env	-.0587555	.0110815	-5.30	0.000	-.0804749	-.0370361
com_loca	-.025276	.0109351	-2.31	0.021	-.0467084	-.0038437
trust_lo	-.0093013	.0034683	-2.68	0.007	-.0160991	-.0025035
trust_sc	-.0009342	.0037587	-0.25	0.804	-.008301	.0064327
trust_ma	-.0120749	.0036473	-3.31	0.001	-.0192235	-.0049263
trust_NG	.0024619	.0036471	0.68	0.500	-.0046862	.00961
exante	-.0404516	.0082713	-4.89	0.000	-.0566631	-.0242401
year	-.0275756	.0118145	-2.33	0.020	-.0507316	-.0044196
ind_mete	.008251	.0032069	2.57	0.010	.0019657	.0145364
peak	.0014057	.0017125	0.82	0.412	-.0019508	.0047622
est_info	.0009698	.0024728	0.39	0.695	-.0038767	.0058163
est_env	-.000194	.0025688	-0.08	0.940	-.0052288	.0048408
est_labe	.0064304	.0025852	2.49	0.013	.0013635	.0114973
est_lexp	.0050458	.0026874	1.88	0.060	-.0002214	.010313

Marginal effects on Pr(re=1,ee=0)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-5.56e-06	4.02e-06	-1.38	0.167	-.0000134	2.32e-06
sex	.0000499	.00006	0.83	0.406	-.0000678	.0001676
employme	-9.80e-06	.000057	-0.17	0.864	-.0001216	.000102
income	-1.03e-06	1.85e-06	-0.55	0.579	-4.66e-06	2.60e-06
size_hh	.0000161	.000024	0.67	0.500	-.0000308	.0000631
owner	-.0000206	.0000608	-0.34	0.734	-.0001398	.0000985
urban	.0000826	.0000798	1.04	0.300	-.0000738	.000239
duration	-6.51e-06	.0000297	-0.22	0.827	-.0000648	.0000518
env_conc	2.07e-06	.0000183	0.11	0.910	-.0000338	.0000379
air_poll	.000021	.0000518	0.40	0.686	-.0000806	.0001225
climate_	.0001051	.0000769	1.37	0.172	-.0000457	.0002559
resource	-.0000865	.0000683	-1.27	0.205	-.0002205	.0000474
waste_ge	-.0001292	.0000864	-1.50	0.135	-.0002985	.0000401
vote_loc	-.0001171	.0000901	-1.30	0.194	-.0002937	.0000595
com_char	-.0001222	.0001059	-1.15	0.249	-.0003297	.0000854
com_env	.0000635	.000097	0.65	0.513	-.0001267	.0002537
com_loca	-.0001811	.0001563	-1.16	0.247	-.0004875	.0001253
trust_lo	.00003	.0000282	1.06	0.288	-.0000253	.0000853
trust_sc	-1.27e-06	.0000248	-0.05	0.959	-.0000499	.0000473
trust_ma	.0000526	.0000388	1.36	0.175	-.0000235	.0001287
trust_NG	-5.87e-06	.0000242	-0.24	0.808	-.0000532	.0000415
exante	.0000346	.0000651	0.53	0.595	-.000093	.0001622
year	-.0001089	.0001073	-1.02	0.310	-.0003192	.0001014
ind_mete	-.0002581	.0001793	-1.44	0.150	-.0006096	.0000934
peak	-.000044	.0000599	-0.73	0.463	-.0001614	.0000735
est_info	-.0000303	.0000788	-0.39	0.700	-.0001847	.000124
est_env	6.07e-06	.0000803	0.08	0.940	-.0001513	.0001635
est_labe	-.0002011	.0001416	-1.42	0.155	-.0004786	.0000763
est_lexp	-.0001578	.0001239	-1.27	0.203	-.0004007	.000085

Marginal effects on Pr(re=1,ee=1)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	.0002537	.000334	0.76	0.447	-.0004008	.0009083
sex	.0127963	.0076938	1.66	0.096	-.0022833	.0278759
employme	-.0040911	.0081963	-0.50	0.618	-.0201555	.0119733
income	-.0000459	.0002675	-0.17	0.864	-.0005702	.0004784
size_hh	.0077309	.0033268	2.32	0.020	.0012105	.0142514
owner	.0464233	.0088558	5.24	0.000	.0290662	.0637803
urban	.0069804	.0083954	0.83	0.406	-.0094743	.023435
duration	-.0051389	.0041646	-1.23	0.217	-.0133014	.0030236
env_conc	-.0079729	.0025372	-3.14	0.002	-.0129457	-.0030002
air_poll	.0014509	.0076976	0.19	0.850	-.0136362	.016538
climate_	-.0066366	.0064924	-1.02	0.307	-.0193615	.0060883
resource	-.0037196	.0071189	-0.52	0.601	-.0176724	.0102332
waste_ge	-.0056227	.0068957	-0.82	0.415	-.0191381	.0078926
vote_loc	.0039052	.00893	0.44	0.662	-.0135973	.0214078
com_char	.007532	.0091241	0.83	0.409	-.0103509	.025415
com_env	.0610292	.0108043	5.65	0.000	.0398532	.0822051
com_loca	.0336421	.0104139	3.23	0.001	.0132312	.054053
trust_lo	.0089543	.0034234	2.62	0.009	.0022445	.0156641
trust_sc	.0010512	.0037099	0.28	0.777	-.00622	.0083225
trust_ma	.0111394	.0035979	3.10	0.002	.0040876	.0181913
trust_NG	-.0024432	.0036001	-0.68	0.497	-.0094993	.0046129
exante	.0423399	.0081094	5.22	0.000	.0264459	.058234
year	.0335593	.0115939	2.89	0.004	.0108357	.0562829
ind_mete	.0002622	.0001835	1.43	0.153	-.0000973	.0006218
peak	.0000447	.000061	0.73	0.464	-.0000749	.0001642
est_info	.0000308	.0000801	0.39	0.700	-.0001261	.0001877
est_env	-6.17e-06	.0000816	-0.08	0.940	-.0001661	.0001538
est_labe	.0002044	.0001448	1.41	0.158	-.0000795	.0004882
est_lexp	.0001604	.0001266	1.27	0.205	-.0000877	.0004085

Marginal effects of Pr(reee==0)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-.0000806	.0000417	-1.94	0.053	-.0001623	1.01e-06
sex	-.0015319	.000954	-1.61	0.108	-.0034018	.000338
employme	.0001179	.0010071	0.12	0.907	-.001856	.0020918
income	1.67e-06	.0000317	0.05	0.958	-.0000605	.0000638
size_hh	-.000785	.0004143	-1.89	0.058	-.001597	.0000271
owner	-.0059967	.0011697	-5.13	0.000	-.0082893	-.0037041
urban	-.0009934	.0010424	-0.95	0.341	-.0030365	.0010496
duration	.0006842	.000515	1.33	0.184	-.0003251	.0016935
env_conc	.0010511	.0003234	3.25	0.001	.0004173	.0016849
air_poll	-.0002095	.0009434	-0.22	0.824	-.0020586	.0016396
climate_	.0017823	.0008075	2.21	0.027	.0001996	.0033649
resource	4.62e-06	.0008716	0.01	0.996	-.0017037	.001713
waste_ge	-.000344	.0008444	-0.41	0.684	-.0019989	.001311
vote_loc	-.0012821	.0010939	-1.17	0.241	-.003426	.0008619
com_char	-.0013432	.0011411	-1.18	0.239	-.0035798	.0008934
com_env	-.0072181	.0014813	-4.87	0.000	-.0101214	-.0043148
com_loca	-.004433	.0013628	-3.25	0.001	-.0071041	-.001762
trust_lo	-.0009805	.0004267	-2.30	0.022	-.0018169	-.000144
trust_sc	-.0002448	.0004561	-0.54	0.591	-.0011388	.0006491
trust_ma	-.000846	.0004496	-1.88	0.060	-.0017271	.0000351
trust_NG	.0001789	.0004409	0.41	0.685	-.0006853	.0010431
exante	-.00517	.0010921	-4.73	0.000	-.0073105	-.0030296
ind_mete	-.0028233	.0026519	-1.06	0.287	-.008021	.0023744
peak	-.0070047	.0011003	-6.37	0.000	-.0091613	-.0048481
est_info	.0004315	.0016759	0.26	0.797	-.0028532	.0037163
est_env	-.0023052	.0017934	-1.29	0.199	-.0058203	.0012099
est_labe	-.0019931	.001828	-1.09	0.276	-.005576	.0015897
est_lexp	-.0017583	.0018262	-0.96	0.336	-.0053376	.0018209
year	-.0057194	.0015321	-3.73	0.000	-.0087222	-.0027167

Marginal effects of Pr(reee==1)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	-.0005196	.0002665	-1.95	0.051	-.001042	2.81e-06
sex	-.00987	.00611	-1.62	0.106	-.0218453	.0021053
employme	.0007594	.0064881	0.12	0.907	-.011957	.0134759
income	.0000107	.0002044	0.05	0.958	-.0003898	.0004113
size_hh	-.0050574	.0026455	-1.91	0.056	-.0102425	.0001277
owner	-.0386355	.0070354	-5.49	0.000	-.0524246	-.0248463
urban	-.0064006	.0066952	-0.96	0.339	-.0195229	.0067218
duration	.0044082	.0033032	1.33	0.182	-.0020659	.0108824
env_conc	.0067718	.0020252	3.34	0.001	.0028024	.0107411
air_poll	-.0013498	.0060777	-0.22	0.824	-.0132618	.0105623
climate_	.0114827	.0051515	2.23	0.026	.0013858	.0215795
resource	.0000298	.0056156	0.01	0.996	-.0109766	.0110362
waste_ge	-.0022162	.0054416	-0.41	0.684	-.0128815	.0084491
vote_loc	-.00826	.0070349	-1.17	0.240	-.0220481	.0055281
com_char	-.0086542	.0073271	-1.18	0.238	-.0230151	.0057067
com_env	-.0465048	.0088769	-5.24	0.000	-.0639031	-.0291064
com_loca	-.0285611	.0085184	-3.35	0.001	-.0452569	-.0118653
trust_lo	-.0063168	.0027082	-2.33	0.020	-.0116249	-.0010088
trust_sc	-.0015774	.0029358	-0.54	0.591	-.0073315	.0041766
trust_ma	-.0054506	.0028619	-1.90	0.057	-.0110598	.0001586
trust_NG	.0011524	.0028398	0.41	0.685	-.0044136	.0067184
exante	-.0333094	.0065925	-5.05	0.000	-.0462304	-.0203884
ind_mete	-.0181898	.0170674	-1.07	0.287	-.0516413	.0152617
peak	-.0451299	.0062727	-7.19	0.000	-.0574242	-.0328356
est_info	.0027802	.0107958	0.26	0.797	-.0183791	.0239396
est_env	-.0148518	.0115138	-1.29	0.197	-.0374183	.0077148
est_labe	-.0128414	.0117605	-1.09	0.275	-.0358915	.0102087
est_lexp	-.0113286	.0117479	-0.96	0.335	-.0343541	.011697
year	-.0368491	.0095103	-3.87	0.000	-.055489	-.0182092

Marginal effects of Pr(reee==2)

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
age	.0006003	.0003075	1.95	0.051	-2.41e-06	.0012029
sex	.0114019	.0070527	1.62	0.106	-.0024211	.025225
employme	-.0008773	.0074952	-0.12	0.907	-.0155675	.0138129
income	-.0000124	.0002361	-0.05	0.958	-.0004751	.0004503
size_hh	.0058424	.003053	1.91	0.056	-.0001414	.0118261
owner	.0446322	.0080568	5.54	0.000	.0288412	.0604232
urban	.007394	.0077333	0.96	0.339	-.0077629	.0225509
duration	-.0050925	.003814	-1.34	0.182	-.0125677	.0023828
env_conc	-.0078228	.0023326	-3.35	0.001	-.0123946	-.003251
air_poll	.0015593	.0070209	0.22	0.824	-.0122015	.01532
climate_	-.0132649	.0059409	-2.23	0.026	-.0249088	-.0016211
resource	-.0000344	.0064872	-0.01	0.996	-.0127492	.0126804
waste_ge	.0025602	.0062853	0.41	0.684	-.0097588	.0148791
vote_loc	.009542	.0081219	1.17	0.240	-.0063765	.0254606
com_char	.0099974	.008461	1.18	0.237	-.0065859	.0265808
com_env	.0537229	.0101887	5.27	0.000	.0337534	.0736925
com_loca	.0329942	.0098137	3.36	0.001	.0137596	.0522288
trust_lo	.0072973	.0031246	2.34	0.020	.0011733	.0134213
trust_sc	.0018223	.0033913	0.54	0.591	-.0048246	.0084691
trust_ma	.0062966	.0033041	1.91	0.057	-.0001793	.0127726
trust_NG	-.0013313	.0032804	-0.41	0.685	-.0077608	.0050982
exante	.0384794	.0075671	5.09	0.000	.0236481	.0533107
ind_mete	.0210131	.0197056	1.07	0.286	-.0176092	.0596353
peak	.0521347	.0071499	7.29	0.000	.0381211	.0661483
est_info	-.0032118	.0124712	-0.26	0.797	-.0276548	.0212313
est_env	.017157	.0132936	1.29	0.197	-.008898	.0432119
est_labe	.0148345	.0135785	1.09	0.275	-.0117789	.041448
est_lexp	.0130869	.0135664	0.96	0.335	-.0135027	.0396765
year	.0425686	.0109419	3.89	0.000	.0211229	.0640143