How to join circular economy without feeling dizzy: the role information in shaping consumer's behaviour. Evidence from Europe

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Abstract

The transition towards the circular economy is a complex process involving fundamental changes to production-consumption systems. This evolution suggests the need to understand what drives individuals' behaviours in this respect. In this framework, the role of information is crucial to influence consumer's behaviours. This paper applies a pseudo-panel approach to the cross-sectional Eurobarometer surveys (2008-2014) in order to evaluate whether reliance on different sources of information has changed over time and across different generation. With the purpose to show potential complementarity across the six drivers (reduce and recycling of waste, saving energy and water consumption and use of eco-friendly and local products) of the circular economy we develop a multivariate multiple regression model. The combined findings provide considerable support for the causal flow leading to understand how the role of information and trustworthiness changed the consumption behaviours over time and what source of information is more reliable for each generation.

Keywords: Circular economy, consumer behavior, pseudo-panel, multivariate analysis.
JEL Classification: Q53, Q58, D12

1 Introduction

Starting from a scoping study on the links between public communication, environmental policy implementation and behavioural science (EEA 2016b), we explore how information can further improve pro-environmental behaviour concern the circular economy. The concept of "circular economy" that emerged in Europe and in the rest of the world, gradually aims to substitute the "take-make-consume-throw away" pattern (EEA 2016a). The transition to circular economy is a complex process involving fundamental changes to production-consumption systems at many

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levels (e.g. international, national, local, business and individual) and in many policy areas. Governments and other policy-makers see the premise of this new business models that would push for waste reduction, resource efficiency and other environmental gains as an opportunity to tackle local socio-economic issues[1].

At individual level, the "circular economy" needs systematic shifts in consumer habit, with implications for everyday behaviours towards consumption and environmental protection. Quoting the *Eu Action Plan for the Circular Economy*[2], consumers can support or hamper the circular economy. This behavioural change of consumers should be based on sharing, leasing, reuse, repair, refurbishment and recycling. Individual's choices are shaped by the information to which consumers have access, the regulatory framework and the range and prices of existing products. For example, consumers often find difficult to decide which information can be reliable between different labels (Teisl, Roe, and Hicks 2002, Ibanez and Grolleau 2008) or environmental claims (EC 2014).

It is important to estimate the effect of information for different consumer's habits for policy appraisals in order to promote the circular economy framework. Therefore, policy efforts should be increasingly directed at using levers, such as mass-media, that influence consumers behaviours towards healthier and more sustainable environmental choices. Moreover, the influence of trust and confidence as driver of consumer behaviours was examined, consistent with researchers also acknowledge that trust relationships are widespread for consumer behaviour (Coleman 1994). Since the effect of information and trust on one behaviour could affect the others, it is also important to estimate complementarities and/or substitutabilities among this different habits. That is, we aim to test differences in the effect of a given set of information and reliable source taking into account the inter-dependency of decisions on the several kinds of behaviours.

Several strands of literature have explored the relation between information and environmental behaviours, by highlighting the potential dependence and vulnerability of people to information provided by media (e.g. Jensen and Hurley 2005), and showing that contextual media and social exposure are important antecedents to the attitude-intention-behaviour model (Ajzen 2001; Lee 2011). In fact more information induces changes in behaviour because enables individuals to perceive alternative actions (Stern 1992 and can influences the resolution of a problem (Fischer 2008, Kahneman 2003).

[1]EU Circular Economy package http://ec.europa.eu/environment/circular-economy/index_en.htm

[2]EC - Closing the loop - An EU action plan for the Circular Economy (COM(2015 614 final))

As the threat of climate change has become more apparent, several scholars have tested whether awareness efforts are effective at changing behaviour related to climate change. Some authors find that coverage of environmental problems had an immediate but short-term influence on public concern (e.g. Sampei and Aoyagi-Usui 2009). Previous assessment of the impact of the mass-media campaign, find that success of a campaign was narrowly defined in terms of individual changes in the short term with respect to knowledge, problem awareness, willingness to show ecologically sound behaviours and attitudes towards policy measures (Staats, Wit, and Midden 1996; Jacobsen 2011).

The key methodological limitation of these studies is the use of either national aggregate time series data or are focused on one kind of environmental problem. In order to account unobserved heterogeneity between individuals and stronger causal inference it would be required individual-level of longitudinal panel data that have the advantage that individuals themselves can be used as controls. Therefore, genuine panel data is more difficult to obtain than cross-sectional. One solution is the ”pseudo panel” approach. This methodology based on cross-sectional data, cover the lack of individual-level panel data characteristics present in our data set. This approach is immune to attrition bias compered to true panels and is prone to instrumentation bias if the study variables were measured differently in subsequent surveys. We present a balanced pseudo-panel data set using cohorts rather than individuals as unit of analysis (Deaton 1985). Cohorts are defined by a set of characteristics (e.g. age, gender, country) which do not change or remain broadly constant over time. It is assumed that although the individuals within cohorts change between waves of cross-sectional surveys, the cohort itself can be viewed as a consistent panel ”member” over time.

Moreover, using age cohort it reflect the need to test the causal link between generational differences in media choices and ”green” habits. Indeed, generational diversity is one aspect of diversity that almost every organization has, such as ethnicity, gender, religion, and culture. In order to captures the complementarities and/or substitutabilities among these different habits related to the circular economy (reduction and recycling of waste, saving energy and water consumption and use of eco-friendly and local products) it is assessed a simultaneous estimation by a multivariate model.

To the best of our knowledge, apply a multivariate empirical strategy to pseudo-panel data is a novel contribution to the empirical literature. Secondly, we address six dimensions of consumer's

behaviour towards the circular economy and this is a first step to contribute a the rising literature of the circular economy from a consumer point of view. Moreover, analyze the relationship between the effect of trust in different sources of information and several "green" habits simultaneously give additional results at the existing literature that connect normally trust and one kind of behaviour (e.g. Petts 1998). Third, we explicitly take into account the inter-dependency of decisions.

Our empirical investigation is based on data provided by three waves of the Special Eurobarometer Surveys (EBs) #295, #365 and #416 respectively for 2008, 2011 and 2014 on citizens' opinion, attitudes and behaviour towards the environment.

The economic and policy question of this paper is: does information improves the efficiency of the economy by providing consumers more and better ability with which to make pro-environmental decisions? To answer at this question, we assess two key research hypotheses:

Hypothesis 1: Trust in information affects the generational behaviours towards the circular economy.

Hypothesis 2: Information that have an effect on a given kind of environmental behaviour also affect the other types of behaviour.

The paper is structured as follows: section 2 presents the methods and research design, section 3 discuss the results of the econometric analysis and section 4 presents conclusion.

2 Methods and Research Design

2.1 Data

Data's source for this analysis comes from three Special Eurobarometer surveys (EB) on citizens' opinion, attitudes and behaviour towards the environment[3]. These EB are a cross-sectional surveys at individual level for 2008, 2011 and 2014 covering 76,920 observations representative of the national EU-27 countries[4]. Data are collected via a multi-stage random sampling design to attain samples that are representative of the EU population.

For this analysis from the eight different "green" habits weighted on the surveys we use reduction of waste, recycling, attention for eco-friendly and local products and sustainable energy

[3]The Eurobarometer #295 (2008), #365(2011) and #416 (2014) primary data files are publicly available from GESIS http://www.gesis.org/en/eurobarometer/data-access/

[4]Data about Croatia are not taken into account because the ratification process was concluded on 21 June 2013 and, Croatian respondents are present only in the Special Eurobarometer Survey #416 of 2014.

and water consumption with respect to the key measures of the circular economy framework. Answers related to a sustainable use of means of transport were not taken into account. On the consumption side, transportation is a measure that indirectly helps the shift from the present business-as-usual model to circular economy. Use of environmental friendly way of travelling (e.g. bicycle, by foot, public transport) or reduced car use, suggest that the quality of consumption patterns affects the environmental impacts. In these surveys are not specified the sharing that is one of the key concept behind collaborative consumption models.

In addition to the individual information, the data allow us to take into account differences between the 27 European countries. We select the gross domestic product (GDP) per inhabitant and the percentage of general government expenditure for environmental protection on GDP (Eurostat 2007, 2010 and 2013). Moreover we use kg per capita of recycling as principle that aims to encourage the options that deliver the best overall environmental outcome. Indeed, waste management plays a central role in the circular economy, it determines how the EU waste hierarchy is put into practice.

Due to the focus on the role of mass media as a channel through which people construct their environmental behaviours, we have included also, a measure of freedom of press: "Freedom of the Press index"[5] that assess the degree of print, broadcast, and digital media freedom. "Free press index" identifies the countries within one of three types of status: Free, Partly Free and Not Free. We have re-scaled the index scores in (0-1) where 1 indicates free of press[6] and 0 partly free[7] because no European country have "not free" status.

[5]Selected data from Freedom House's annual press freedom index. Countries are given a total score from 0 (best) to 100 (worst) on the basis of a set of 23 methodology questions divided into three subcategories. The degree to which each country permits the free flow of news and information determines the classification of its media as "Free", "Partly Free", or "Not Free". Countries scoring 0 to 30 are regarded as having "Free" media; 31 to 60, "Partly Free" media; and 61 to 100, "Not Free" media.

[6]Free of press in
2007: Austria, Belgium, Cyprus, Czech Rep., Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden, United Kingdom, Luxembourg, Spain.
2010: Austria, Belgium, Cyprus, Czech Rep., Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden, United Kingdom, Luxembourg, Spain.
2013: Austria, Belgium, Cyprus, Czech Rep., Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden, United Kingdom, Luxembourg, Spain.

[7]Partly free of press in
2007: Romania, Bulgaria
2010: Romania, Bulgaria, Italy
2013: Romania, Bulgaria, Hungary, Greece, Italy

2.2 Constructing the pseudo-panel

We propose a balanced pseudo-panel model that makes use of longitudinal variation on the basis of independent cross-sections. Following the original Deaton's approach (Deaton 1985) we generate a panel data set with cohorts as units of analysis that are defined by characteristics that are time-invariant such as the year of birth, gender and country. In other words, in a pseudo-panel, we do not track individuals over time; rather, we track groups of individuals. The average group characteristics are treated as observations. This implies that the "similar" individuals are included in each group (Verbeek and Nijman 1992).

It should be considered the trade-off between number of cohorts (denoted by C) and the number of individuals in each cohorts (denoted by ind) when the pseudo-panel is set up: the larger the C, the lower the extent of measurement errors and increases the heterogeneity of the pseudo-panel, but also decreases the average ind per cohorts. Moreover, bias and imprecision of estimators can be limited by increasing the size of cohorts. In literature, it is generally considered that 100 individuals per cohort is enough to ignore sampling errors (Verbeek and Nijman 1992). Another problem is important taken into account, forming large cohorts means that the number of observations used for the pseudo-panel model will be reduced. As in our case, the solution is to increase the size of the cohorts by broadening the generations (e.g. by ten-year age brackets). However in this case, the variability of observations at a given date is reduced, as the final number of useful observations decreases. Several generations and grouping close also means that the variability is reduced over time. These two elements (number of observations used for the estimation, low variability) are both factors that traditionally reduce the precision of the final estimator. Obviously, it is important observe the variation over time of the variable observed, in order to assess how strongly they are correlated. This reflects a classic bias-variance trade off.

In our case, the level of aggregation is much closer to the individual level than to the country level. We assume that grouping variable is strictly exogenous and that the group means vary across groups and time (Inoue 2008).

The balanced pseudo-panel comprises a fixed total number N of 76,920 individuals in the repeated cross-sectional dataset over time periods T (an average of 25.000 observations for each year), by definition, $N = C \times ind \times T$. As we are specifically interested in distinguishing the effect of information for different generation, the pseudo-panel is composed by 486 observations,

defined by 6 age cohorts (15-24, 25-34, 35-44, 45-54, 55-64 and >65), and 27 European countries. The resulting average number of individuals per group, is 150 with $N = 76,920$, $C = 162$ and $T = 3$. Cohort size are deemed to be large enough to neglect measurement errors of population means (Verbeek 2008).

Table 1 summarizes the characteristics of the groups.

[Table 1]

Another alternative way to construct cohorts was tested in sensitivity analysis: 324 cohorts defined by age, gender and country.

The literature stresses two different age effects: a cohort effect resulting from belonging to a specific generation and an aging effect due to being at a certain stage of age. The cohort effect refers to the difference in behaviours between different age-groups due to generational differences in economic conditions, socialization or experience (D. A. Vlosky and R. P. Vlosky 1999. Thus, we investigate the behaviour of the same age groups in different time periods (cohort effect), but we do not provide information on intra-cohort mobility. The Figure 1 compares the average "green" behaviour of different cohorts for the three years analyzed. There are sometime significant differences: a change of basic habits and values in a population does not occur within a generation, but between generations. Unfortunately, as a new generation grows up the change should only slowly become visible in aggregate data. In wider terms people aged between 45 and 64 are the greener. A period of six years might not be long enough to detect such a long-term process, but we can observe that in Europe, use of eco-friendly products is the lowest pro "circular economy" behaviour. Counter trend, reduce waste and save resources (energy and water) habits decreased from 2011 to 2014.

2.3 Variables and assumption

Three different types of variables can be used to represent the various characteristics of the pseudo panel data cohorts. A given characteristic can be represented by (a) a continuous variable, (b) one or more dummy variables, or (c) one or more proportional variables. The type of variable or variables formed to represent a given characteristic is, for the most part, dictated by the type of individual information collected in the surveys and its relationship to the cohort definitions.

For each cohorts weighted by country, the proportion of individuals who adopt determined

habits, was used as dependent variable. We examine the six dependent variables related to the drivers of the circular economy: (1) reduce waste, (2) recycling, (3) saving water consumption, (4) saving energy consumption, (5) use eco-friendly products and (6) use local products, denoted by Y^*_{cjt}. However, from a correlation matrix (see Table 2), we can see that options 2 and 4 could both be categorized as push instruments and have the strongest correlations (.86), while options 3 and 5 have the weakest one (.41).

[Table 2]

According to the role of mass media to orient the consumer choices and the role of consumer in the transition towards the circular economy (EEA 2016b), the explanatory variables include measures respectively for: (1) individual information level on environmental issue, sources of information used: (2) old media (tv, radio and newspaper), (3) Internet, (4) peer norms, (5) other (books and events) and trust in: (6) media (old media and internet), (7) peer norms, (8) consumer organization, (9) environmental organization, (10) companies, (11) international institutions, (12) scientists and (13) national institutions, denoted by $INFO_{cjt}$. The Table 3 shows the descriptive statistics computed from the dataset used.

[Table 3]

Old media represents the most important source of information in Europe for environmental issues. It is interesting to note that there is a decrease over time in favour of Internet. In contrast, there is not difference on which source is more reliable because there is an increase of trust for both old and new media over time. People trust principally in scientists and environmental organization while trust in national and international institutions is decreased over time.

The trustworthiness of information has been shown in literature to be an important correlation of interpretation of environmental problem and resultant support or opposition to policy choices in the face of problem (Kellstedt, Zahran, and Vedlitz 2008). Building consumer trust has become an important goal in different policies that concern to the circular economy package. The trustworthiness of the source providing environmental issues can influence people's motivation to process a "green" consumption.

We expect that trust in expert (national and international institutions, environmental and consumer organization and scientists) is associated with a stronger willingness to contribute to circular economy process. Especially governments are responsible to provide public goods like

environmental quality. So, the suspected effects on trust in government are unclear. There could be an increase of lack of trust in government on environmental problems, if individuals live in country where the government not properly taking care these problems. On the other hand, individuals are less willing to contribute to the protection of public goods when they can simply enjoy the benefits of non-rival and non-excludable public goods provided by the government. In literature this behavioural change caused by an external intervention, is explained as a shifting of the *locus of control*[8] away from individuals. Indeed when government intervenes via command and control regulations it prescribes a particular behaviour subject to sanctions. In other words, this intervention cause a restriction of autonomous actions, consumers' responsibility is reduced and imply a lower self-perception of a higher exercise of environmental behaviour. On the contrary when government use legal system to influence behaviour, the citizens are clearly informed that an environmentally friendly behaviour is expected of them. This involves a reinforcement of existing environmental behaviour (Frey 1999). General trust in other people such as friends, family, neighbours or co-workers is visible for cost-saving activities and altruistic behaviours towards resolution of local problem, volunteering and recycling (Videras et al. 2012) dictated by social norms. We expect that trust in peer are correlated with saving resource consumption.

The different sources of information used may vary with individual levels of information on environmental issues. For topics in which audiences do not possess direct knowledge, the media can favour or limit the information with which consumers understand the environmental issues. We expect that the media help to develop possible changes in personal behaviours. Moreover, like studies on the influence of green family profiles and altruistic and community-based behaviours (e.g. Videras et al. 2012) on pro-environmental behaviour, we suppose that the information on environmental issue provided by social relationships and conversation with family and friends is an important driver that increases positive effect on behavioural change.

Four other time-variant independent variables were also tested, namely the proportion of individuals being unemployed, employed or are student (self employed is the reference group), having an higher and lower (medium level of education is the reference group), living in urban area and being net user in order to determine the profile of citizens that have an active role in the transition towards the circular economy. Country characteristics, as explained in the previous section were also included: namely the continuous variable (log value) of GDP per capita, kg per

[8]Locus of control is the extent to which people believe that they have the ability to affect outcomes through their own actions (Rotter 1966)

capita of material recycled, percentage of government expenditure per environmental protection of 2007, 2011 and 2013 and a dummy variable of freedom of press index. The estimation includes also year dummies in order to control for the annual trend and any potentially omitted independent variables that change linearly over time (e.g., mean age of the subgroup). The square of the mean age of subgroup was also tested to account for a potentially non-linear relationship between "green" habits and age.

2.4 Model specification and testing

A multivariate multiple regression model that allows a simultaneous estimation of the six behaviours was tested, in order to verify the complementarities and/or substitutabilities between different drivers of the circular economy due to an effect of information. The general specification for a six-equation model would be:

$$\overline{Y}^{*}_{cjt,m} = \beta_k Info_{cjt,k} + \beta_h Control_{cjt,h} + \psi_{c,m} + \varepsilon_{ct,m} \tag{1}$$

where $Y^{*}_{ct,m}$ might represent outcomes for $M(m = 1, \ldots, 6)$ different choices for consumer for age group $c(c = 1, \ldots, 6)$ at time $t(t = 2008, 2011 and 2014)$. The dependent variables in the model represent the following behavior: y_1 reduce waste, y_2 recycling, y_3 cut down water consumption, y_4 cut down energy consumption, y_5 buy environmental friendly products and y_6 use local product. The bar denote population cohort means. $Info$ is a vector of exogenous variables related to information, $Control$ is a vector of variables related to individual and country characteristics which are hypothesized affect the individual behaviour, $\psi_{c,m}$ is the specific unobserved time-invariant heterogeneity and ε is the classical idiosyncratic error term, both specific to the equation of the m-th behaviour. To account for the different size of the subgroups, weighted were applied using *ind* as weights. We are modeling the consumer decisions by controlling for both the interdependencies between the six drivers and time-invariant unobserved heterogeneity given the likelihood of complementarities between different types of environmental behaviours. The assumption of complementarities between behaviours leads us to estimate this model using a correlated random-effects approach a la Mundlak (Mundlak 1978) through maximum simulated likelihood. The Mundlak approach has been implemented including in each of the M equation of the system the time avarages $\psi_c = \pi \overline{X}_c + v_c$ [9], of the time-varying covariates as additional

[9] where $\overline{X}_c$ is the time average of X_{ct}, picks up any correlation between X_{ct} and ψ_c.

explanatory variables.The correlated random-effects (CRE) approach relaxes the assumption of zero correlation between random-effects and covariates. As far as we know, this is a novel contribution to the empirical literature related to individual behaviour.[10].

In order to analyze the generational tendencies between sources of information and drivers of the circular economy, we have also tested a multivariate model including interaction terms. Adding interaction terms to a regression model can greatly expand the understanding of the relationships among the variables in the model.

3 Results

Table 4 shows the results from the estimation of the multivariate CRE model: each column reports the specification for *reduce waste*, *recycling waste*, *saving water*,*energy consumption*, *use of eco-friendly* and *local products* respectively. The associated cross-equation correlation matrix is in Table 5, which clearly shows complementarities or substitution effects between the six behaviors[11]. We believe that this technique is the most appropriate to address simultaneously the six habits because the proposed model allows for the estimation of correlation across the errors of the six equations.

[Table 4]

The results of estimation are consistent with the research hypotheses. Generally, people with a higher level of information on environmental issues are pro "circular economy" above all to reduce and recycle waste and saving energy consumption. On the one hand, some sources of information and the related trustworthiness are not significant for some behaviour, but as we explain below, several key variables provide relevant insights.

As regard research hypotheses, most of the coefficients are in the direction predicted by the literature.

Firstly, as assumed in section 1.3, *trust in environmental and consumer organizations* have a positive and significant impact. Moreover *trust in consumer organizations* to take steps to recycle, reduce water and energy consumption will increase the likelihood that people will actively reduce their own water and energy use and increase the reuse of waste. "Waste reducers" are the only group, that are not affected by this kind of organizations. *Trust in national institutions*

[10]. We use the *cmp* Stata command for practical implementation (Roodman 2011)

[11]We don't report the time averages of the time-varying covariates that are jointly significant. This suggest the presence of time-invariant unobserved heterogeneity that is correlated with the explanatory variables.

have a significant positive effect on the proportion of individuals in the cohorts who reduce waste and recycle. These outcomes, as assumed in section 2.3, implies that consumers interviewed, live in countries where the government takes care the problem of waste and this is confirmed by the significant and positive coefficient result in country where there is higher per capita municipal material recycled.

Counter-trend the negative and significant impact of *trust in scientists* on "waste reducer" that confirm previous research (Kahan, Jenkins-Smith, and Braman 2011) where is explained that culturally diverse persons, like our case, tend to form opposing perceptions of what experts believe. It is like saying that people in many cases seem to ignore certain environmental risks despite the existence of scientific evidence that an activity or event constitutes a risk to human health (Lidskog 1996.

This result is a starting point to underline that the trustworthiness of some sources of information for "waste reducer" are different from "recyclers" and involves that information that shape recycling actions are not sufficient to promote waste reduction dynamics. This is verify also by the use of internet and old media sources that have a positive and significant effects on "waste reducers" but negative and not significant on "recyclers". The effect of *trust in companies* underlines our findings on the difference between reducers and recyclers, and highlights the negative and significant impact on people that reduce energy consumption. This effects would be interpreted by the best known "rebound effect": the consumer feels itself not responsible and free to consume more energy or not recycle waste due to effort promoted by companies that produce and promote energy by renewable resources or new "green" product for example by recycled material.

Trust in international institutions has an ambiguity effect on the drivers taken into account. On the one hand, we have a negative and significant effect on "local product users" compared with the positive effect of *trust in national institutions*, to the other hand a positive and significant effect on people that save energy and use eco-friendly products. The firs one means that the sharing of management power and responsibility of environmental protection that involve cross-level institutional and organizational linkages among national and international governance is not understood by individual that trust only in national efforts. The second result, reflects the efforts by international policy relevant such as the relationship between energy and climate change that is one of the most important challenges of the millennium or the relationship be-

tween global governance and international trade that is a key determinant for eco-innovative behavior in firms (Rennings 2000).

People that saving water and energy consumption are influenced differently by the source of information. "Energy conservator" like "waste reducers" and "local product users" are affected positively by old media. Instead, "Water conservators" are affected negatively by *peer norms* to reach an higher level of saving, that is confirmed also by the results of trust in this sources. We found that individuals' inclination to act in a pro-environmental way are influenced in ambiguity way by the peer's actions and in particular how they perceive the peer's behaviours. The findings show a negative effects overall with respect to curtailing water relative to use of local products, which probably reflects the fact that the peer norms on resources saving actions are less invasive than when people purchase local products.

Finally, given the positive and significant correlation between the equation errors *rho* (Table 5), the H2 is confirmed and the assumption that the error terms across equations are uncorrelated can be rejected[12], confirming that the use of multivariate model is more appropriate than estimating six independent models.

[Table 5]

They mean that those individuals which register a higher likelihood of developing one type of examined behaviours are also more likely to implement the other five types. The negative or not significant results related to the correlation between reduce water and energy consumption and the other behaviours suggests that measures informing people of the environmental implications of excessive water and energy consumption are not sufficient and must have a significant complementary part to play. This is a novel result, since many past researches do not acknowledge these complementarities across types of environmental behaviors. Due to the observed correlation across the error terms of the six equations involved in the multivariate model, we may affirm that, after controlling for the observable characteristics of individuals and their context, there remain unobserved factors (controlled by Mundlak approach) which are common to all six actions related to circular economy and positively drive them.

With respect to socio-demographic characteristics, people living in country with higher GDP per capita and in urban area have a lower propensity to reach an higher level of green habits.

In order to know the most used source of information for each generation, Figure 2 shows the re-

[12] the Wald Chi-Square test statistic rejects the null hypothesis

sults for interaction terms with significant estimated coefficients [13]. The presence of a significant interaction indicates that the effect of one predictor variable on the response variable is different at different values of the other predictor variable. The coefficients display closed squares that represent point estimates and bar represent confidence intervals. These graphs provide a much better impression of statistical precision than p-values or significance stars in tables and which coefficients are significantly different from zero.

[Figure 2]

4 Conclusion

This paper highlights the impact of several sources of information as drivers of consumer behaviours towards the circular economy in European member states. The circular economy framework, actually is at the top of the European target for a green growth. The combined findings provide considerable support for the causal flow leading to understand the impact of information as drivers of inter-generational patterns of "circular economy" habits.

As well as the advantages associated to the use of pseudo-panels approach are related to measurement error at the individual level because they follow cohort means. Furthermore our pseudo panel dataset consider the trade-off between the number of cohorts and the number of observations in each cohort. The size is large enough in order to average characteristics per cohort will not be error-ridden measurement of the true cohort population values mckenzie2004asymptotic. However, this feature also imposes some limitations. Namely, the degree of unobserved heterogeneity may not be completely controlled. When constructing groups in pseudo-panels, we assumed that the country people live do not generally change over time. While the validity of this assumption may be questioned, we think they reasonably hold given the limited time period of the data (2008âĂŞ2014) and the large size of the countries. This is the first paper that assess simultaneously multiple empirical and conceptual challenges faced by studies of consumer behaviour using a pseudo panel dataset and a robust empirical methodology.

From the analysis of the drivers of the circular economy, we find that reduce waste is complementary to recycling, reduce energy consumption and using eco-friendly and local products, recycling and saving water consumption are complementary to saving energy and using eco-friendly and local products. Namely, the consumer who develops one type of behaviours is more likely to

[13] Complete table of results is available upon request

develop the other behaviours influenced by the source of information considered trustworthy. These findings have important implications since they suggest that the promotion of "circular economy" may exploit these complementarities to enhance their effectiveness.

We pointed out the existence of differences in individual among European Union countries (annex Figure 3). We tried to explain these significant contextual effects by introducing some variables at national level that partially explain the differences between countries. Although the introduction of these contextual variables, a certain degree of intra-national variability still remain. These results suggest that even if a global and coordinated European policy strategy is required in order to implement the circular economy framework, each country's peculiarities must be taken into consideration and can become more effective by exploiting the synergies between different drivers.

The key implication of this study for policy makers is that they can utilize these evidence to understand which are the strength and the weakness of several sources of information for each generation in order to promote a specific pro-environmental behaviour.

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5 ANNEX I

Table 1: Definition and size of cohorts

Age cohorts	Mean number of individuals (Min, Max) 2008	2011	2014
15-24	111	114	89
	(35-199)	(40-187)	(36-140)
25-34	140	144	131
	(54-191)	(60-200)	(65-208)
35-44	162	163	156
	(72-257)	(61-225)	(69-228)
45-54	165	166	167
	(76-277)	(83-265)	(69-260)
55-64	162	165	170
	(92-253)	(70-290)	(65-269)
>65	205	210	225
	(113-373)	(73-467)	(79-441)

Table 2: Correlation matrix between the six drivers of the circular economy

	1	2	3	4	5	6
Reduce waste	1.000					
Recycling	0.859	1.000				
Saving water	0.678	0.736	1.000			
Saving energy	0.826	0.865	0.855	1.000		
Use eco-friendly prod.	0.612	0.693	0.409	0.642	1.000	
Use local prod.	0.692	0.680	0.502	0.690	0.647	1.000

Table 3: Descriptive statistics

Variable	2008	2011	2014
Level of information on environmental issues	56%	61%	67%
Source of information used:			
Old media	95%	95%	92%
Internet	23%	31%	41%
Peer norms	12%	16%	13%
Other	15%	16%	17%
Trust in:			
National institutions	15%	14%	12%
International institutions	24%	24%	21%
Companies	4%	5%	4%
Environmental organizations	41%	43%	41%
Consumer organizations	15%	20%	16%
Scientists	44%	49%	49%
Peer norms	7%	12%	11%
Media	33%	51%	64%

Source: elaboration of the authors based on EBs 2008, 2011 and 2014 sample.

Table 4: Determinants of circular economy. Multivariate regressions (estimation results).

	Reduce waste	Recycling	Saving water	Saving energy	Use eco-friendly	Use local p.
Level of information	0.180***	0.165**	0.072	0.194***	0.002	−0.077
Source of information used:						
Internet	0.128**	−0.072	−0.104	0.043	0.072	0.377***
Old media	0.216*	−0.206	0.152	0.265**	0.004	0.408***
Other	0.159*	0.207*	0.081	−0.048	−0.015	0.081
Peer norms	−0.010	−0.150	−0.286***	−0.015	0.393***	0.114
Trust in:						
National Inst.	0.266***	0.190**	0.128*	0.088	0.037	0.153*
International Inst.	−0.086	0.103	0.103	0.277***	0.266***	−0.172**
Companies	0.107	−0.546***	−0.065	−0.515***	−0.109	−0.074
Environmental. Org.	−0.039	0.028	−0.032	0.100	0.124***	0.349***
Consumer Org.	0.039	0.225***	0.536***	0.250***	−0.045	−0.199
Scientists	−0.140***	−0.092	0.054	0.002	−0.021	−0.050
Peer norms	−0.017	−0.134	−0.103	0.052	0.116	0.270**
Media	−0.046	−0.054	−0.116**	−0.053	−0.041	0.113*
Socio-demographic characteristics:						
Low education l.	−0.008	−0.145*	−0.076	−0.108*	−0.043	−0.055
High education l.	−0.071	−0.032	−0.066	0.057	−0.089**	−0.115*
Worker	−0.029	0.033	−0.093	−0.148*	−0.084	0.075
Student	−0.031	0.136	−0.189	−0.155	−0.152	0.047
Live in urban area	−0.009	−0.165**	−0.064	−0.164***	0.073	0.026
Net user	0.152	0.000	0.195**	0.204***	0.157	−0.020
age	0.010***	0.006	0.002	0.008***	0.004	0.003
age^2	0.000***	0.000	0.000	0.000***	0.000	0.000
gender	0.145	0.113	0.058	−0.037	0.054	0.132*
GDP lagged (log.)	−0.003	−0.149***	−0.085***	−0.080***	0.008	−0.015
Free press index	−0.029	−0.064*	−0.043	−0.011	0.015	0.037
% environmental exp.	−0.007	−0.036	−0.011	−0.060***	0.001	0.022
Municipal recycled material	0.012	0.085***	−0.001	0.008	−0.015	0.014
y2	0.044***	0.095***	0.032*	0.039***	−0.018	0.000
y3	−0.018	0.183***	0.000	−0.004	0.037*	0.056*
Constant	−1.207***	−1.628***	0.708***	−0.665***	−0.626***	−0.297

* p<.1, ** p<.05, *** p<.01

The time averages of the time-varying covariates are jointly significant suggesting the presence of time-invariant unobserved heterogeneity that is correlated with the explanatory variables. Results for each equation of the system are available from the corresponding author upon request.

Table 5: Correlation matrix

	Reduce waste	Recycling	Saving water	Saving energy	Use Eco-f. p.	Use Local p.
Reduce waste	1	0.347***	0.0237	0.139***	0.150***	0.341***
Recycling		1	0.0690	0.123***	0.0885*	-0.0908**
Saving water			1	0.634***	-0.115**	-0.0934***
Saving energy				1	-0.0696	0.0398
Use Eco-f. p.					1	0.422***
Use Local p.						1

Figure 1: "Circular economy" behaviours according to age group and period.

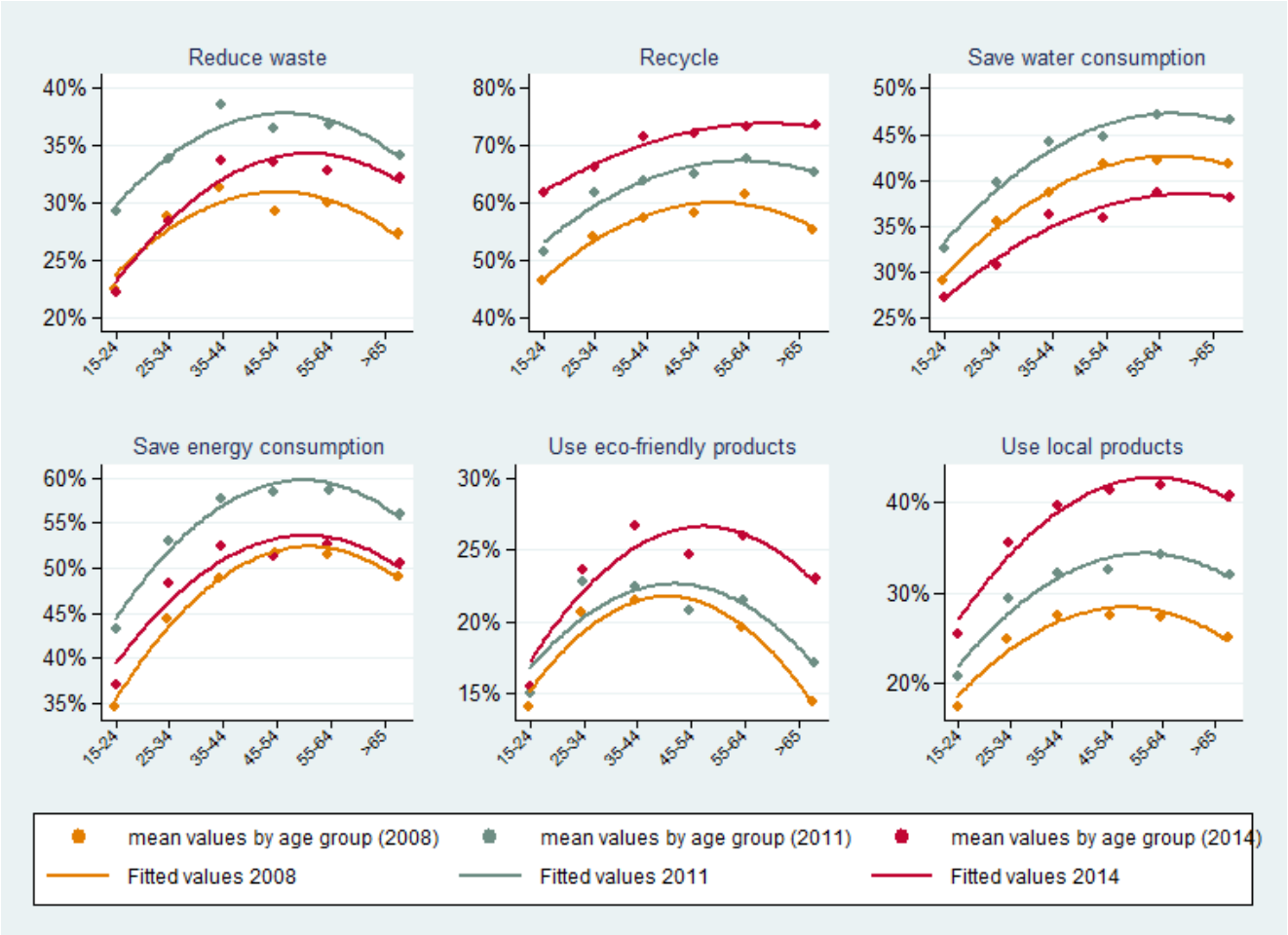


Figure 2: Effects of information on the six behaviours towards the circular economy (significant regression coefficients of interaction terms).

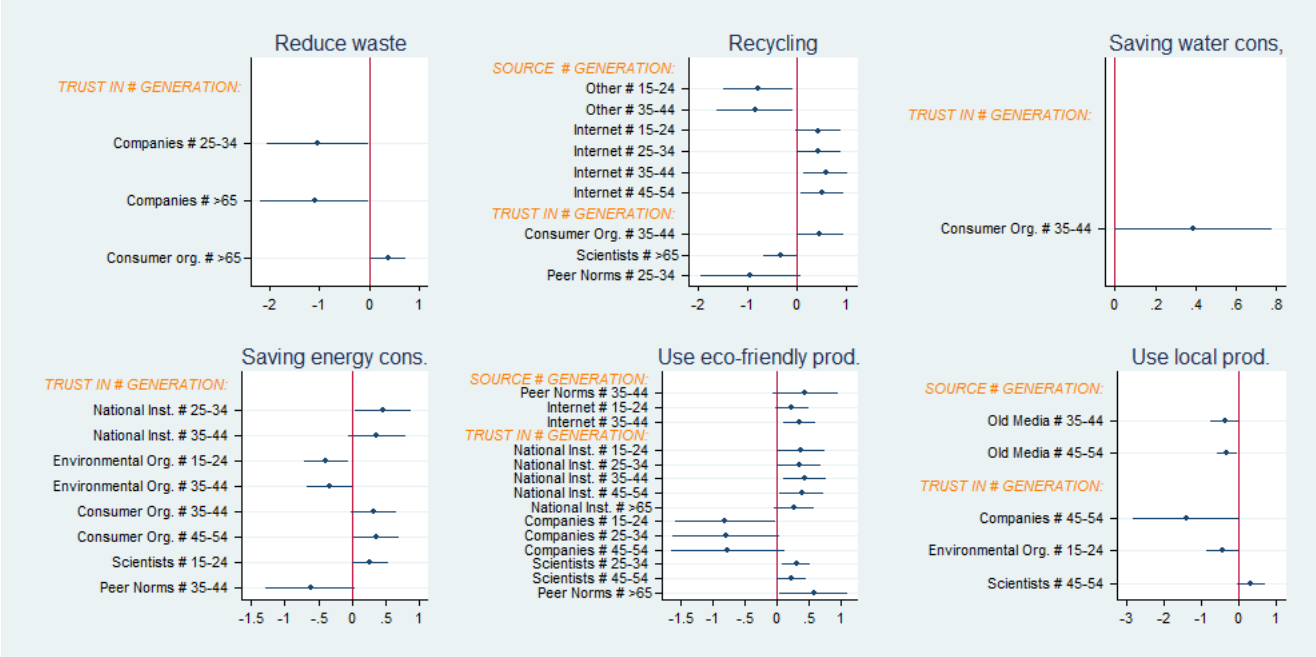
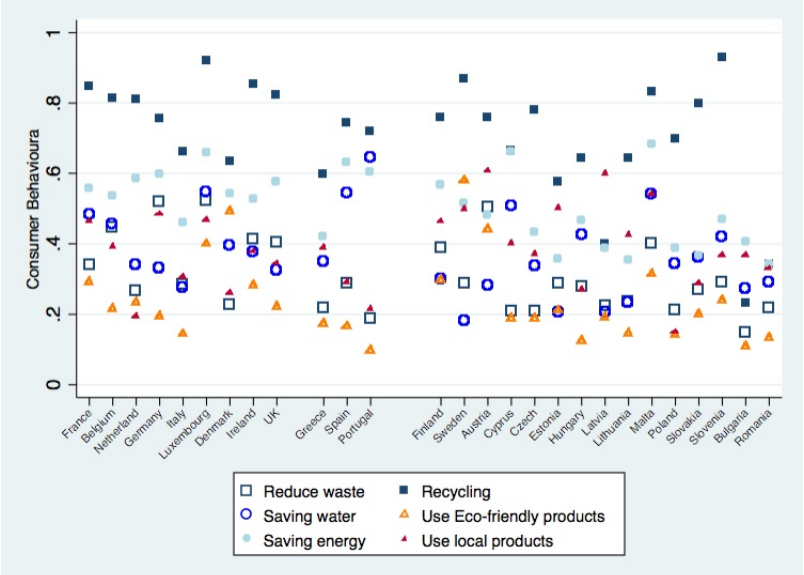


Figure 3: Country characteristics



Source: elaboration of the authors based on EBs 2008, 2011 and 2014 sample.