PREFERENCES TOWARDS CO_2 CAPTURE AND STORAGE IN THE EUROPEAN UNION. A STRUCTURAL EQUATION MODELLING ANALYSIS

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Abstract

The paper analyses the impact that European Union citizens' access to information on climate change has on their awareness of carbon capture and storage (CCS), perceived risks and benefits of using CCS and stated choice of preferred CCS options**.** We use Eurobarometer data about awareness/acceptance of CCS and run structural equation models for twelve EU countries with an average sample size of 1100 observations per country. Results between the different countries are comparable and, alongside other determinants, access to information sources significantly impacts CCS awareness, perceived risks and benefits of CCS and preferences towards options of CCS.

Keywords: CO_2 capture and storage, EU citizens' CCS knowledge and attitudes, structural equation models.

1. Introduction

CO_2 capture and storage (CCS) is a set of technologies that facilitates the reduction of CO_2 emissions from coal-based electricity production. In order for CCS to be utilised on a large scale, there is a need for its public acceptance. Based on the results of several studies, it is believed that the CCS awareness of the majority of public is largely nonexistent and therefore it cannot genuinely decide whether it is for or against CCS (Schumann & Simon, 2009). A number of studies have analysed the impact of information on public awareness and perceptions of CCS (Schumann & Simon, 2009; Best-Waldhobera & Daamena, 2011; Huijts *et al*., 2007). Most studies found that information is a key factor influencing public's CCS awareness and perceptions, however, despite increased communication to public, CCS awareness level is still low and better communication strategies are needed. The paper analyses the impact that the European Union (EU) citizens' access to information on climate change (amongst other *a priori* determinants) has on their awareness of CCS, perceived risks and benefits of using CCS and stated choice of preferred CCS options**.**

2. Method and data

We use structural equation models (SEM) with observed and latent variables to test the influence of *a priori* identified determinants on CCS perceptions. SEM is a statistical technique for testing and estimating causal relationships amongst variables, some of which may be latent, based on a combination of statistical data and qualitative causal assumptions. This paper estimates SEM with the normal-theory maximum likelihood method using the statistical package Lisrel 8.80 (Jöreskog and Sörbom, 2007).

The data used in this paper were extracted from the Dataset Eurobarometer 75.1: Public Awareness and Acceptance of CO2 Capture and Storage (Eurobarometer, 2011). We analysed the datasets for twelve countries (United Kingdom, Bulgaria, Czech Republic, Germany, Greece, Spain, Finland, France, Italy, Netherlands, Poland and Romania. The average sample size is 1100 observations per country, ranging from 1000 observations in Greece and Poland to 1622 observations in Germany. The variables included in the analysis are socio-demographic (education and number of children living in the household) and

climate change related (access to information; perceived level of information; CCS awareness; CCS project awareness; perceptions of CCS effectiveness; perceptions of CCS benefits and risks; preferences towards involvement in CCS local decision-making; and preferred CCS options).

3. Results

All twelve models have a very good fit according to the measures of absolute, incremental and parsimonious fit (Hair *et al*., 2006). Table 1 presents the standardised total effects between latent variables in each of the twelve models. All effects (socio-demographics, information and perceptions) on preferred CCS options are specified, while only effects of climate change information and CCS awareness are underlined for perceptions of CCS effectiveness, benefits and risks. Overall, the ranking of determinants' impact on preferred CCS options differs between models, however access to information sources and perceived level of information on climate change, followed by CCS awareness are significant determinants in most models.

4. Discussion

Our findings as regards the significant impact of access to and perceived level of climate change information on preferred CCS options confirm findings from the literature. Namely, the stronger the public's access to more sources of climate change information and its perceived information level, the stronger its CCS awareness and ability to make an informed choice between CCS options. Additionally, more informed people will be more interested to be involved in CCS decision-making process (*e.g*., regarding the potential creation of an underground CO2 storage site near own home). The impact of information on perceptions of CCS benefits is also strong, much more so than its impact on perceptions of CCS risks. This might suggest that more informed people are more likely to perceive the benefits of using CCS as a means to fight climate change and have a more accurate understanding of potential risks.

Amongst other determinants, educational level significantly influences CCS perceptions in most models, however the magnitude of impact differs between models. This confirms findings from the literature, namely that more educated people are more likely to search for information and show stronger perceptions/behaviour towards climate change.

The impact the number of children living in the household has on CCS perceptions is less straightforward. This determinant was not found significant in a third of the models, and shows contradictory influences. Some studies found that respondents with children are significantly more likely to fundamentally oppose CCS than their counterparts, however this is only confirmed in some of our models and the impact was found to be quite low.

CCS project awareness (included only in five models as this question was asked only of the citizens in United Kingdom, Germany, Spain, Italy and Poland, where such projects have been already implemented) has a significant effect in all models, suggesting that people aware of CCS projects are more able to make an informed choice between CCS options.

Table 1. Standardised total (direct and indirect) effects (t-values in parentheses)*.

Observed/ latent variables	Total effects on preferences towards CO_2 storage options as regards future use of CCS in the EU											
	United Kingdom	Bulgaria	Czech Republic	Germany	Greece	Spain	Finland	France	Italy	Netherlands	Poland	Romania
Education	0.11 (4.38)	0.05 (6.38)	-0.10 (-3.47)	-	0.13 (4.12)	0.08 (5.55)	0.03 (3.55)	0.10 (3.30)	0.11 (5.73)	-0.09 (-2.87)	0.11 (5.20)	0.06 (6.31)
Children	-0.15 (-6.14)	-	-	-0.02 (-4.02)	0.01 (2.62)	-	-0.13 (-4.62)	-0.01 (-2.55)	-	0.02 (3.15)	-	0.05 (2.04)
Access to information	0.06 (2.35)	0.16 (9.06)	0.11 (5.56)	0.16 (6.59)	0.05 (5.54)	0.16 (5.37)	0.03 (2.01)	0.05 (4.94)	0.13 (8.06)	0.07 (2.37)	0.20 (6.98)	0.10 (7.73)
Perceived level of information	0.13 (8.33)	0.17 (8.55)	0.08 (4.08)	0.15 (10.03)	0.11 (6.31)	0.12 (6.46)	0.11 (4.75)	0.04 (3.56)	0.27 (11.26)	-	0.14 (7.09)	0.19 (11.20)
CCS awareness	0.20 (5.86)	0.13 (7.74)	0.17 (8.81)	0.11 (8.56)	0.08 (5.05)	0.09 (6.55)	-	0.04 (2.91)	0.09 (2.81)	0.13 (4.01)	-	0.17 (10.17)
CCS project awareness	0.18 (8.92)	-	-	0.01 (2.89)	-	0.09 (6.01)	-	-	0.03 (2.42)	-	0.14 (5.36)	-
Perceived CCS effectiveness	0.44 (13.88)	0.45 (11.20)	0.55 (13.40)	0.40 (12.15)	0.42 (9.49)	0.44 (11.01)	0.63 (13.41)	0.29 (9.49)	0.66 (13.94)	0.34 (7.37)	0.55 (13.67)	0.42 (12.18)
Perceived CCS benefits	0.18 (5.66)	-	0.16 (3.07)	-	-0.13 (-2.92)	-	-	0.12 (3.01)	-0.21 (-3.00)	-	0.03 (2.03)	0.46 (12.12)
Perceived CCS risks	0.41 (10.78)	0.18 (4.15)	-	0.08 (5.06)	-	0.17 (4.06)	0.34 (5.57)	0.16 (3.74)	0.07 (3.18)	0.03 (2.11)	0.32 (7.76)	0.30 (7.45)
Perceptions towards CCS local decision-making	0.19 (4.42)	0.23 (5.04)	-	-	0.13 (2.90)	-	0.13 (2.16)	0.11 (2.30)	0.14 (3.36)	0.09 (2.18)	0.12 (2.66)	0.19 (4.44)
R-square	0.47	0.31	0.33	0.23	0.23	0.27	0.50	0.18	0.47	0.15	0.51	0.39
	Total effects on preferences towards involvement in decision-making process regarding the creation of an underground CO_2 storage site near own home											
Access to information	0.08 (6.66)	0.10 (6.65)	0.06 (4.34)	0.12 (9.18)	0.02 (2.82)	0.18 (6.07)	0.13 (4.53)	0.15 (4.82)	0.22 (7.18)	0.01 (2.51)	0.18 (5.86)	0.09 (5.88)

Perceived level of information	0.11 (8.01)	0.21 (6.76)	0.14 (4.53)	0.24 (9.68)	0.04 (2.88)	0.09 (4.96)	0.08 (4.01)	0.01 (2.09)	0.19 (5.06)	0.01 (2.72)	0.02 (2.28)	0.14 (4.57)
CCS awareness	0.17 (4.98)	0.01 (3.25)	-	0.04 (5.28)	-	0.06 (3.57)	-0.06 (-3.05)	-0.04 (-3.19)	-	-0.03 (-2.87)	-0.02 (-2.61)	-
Total effects on concerns as regards the hypothesis of having a deep underground storage site for CO_2 within 5km of own home												
Access to information	0.06 (5.82)	0.13 (8.08)	-	0.08 (6.69)	-	0.10 (6.03)	0.03 (2.81)	0.08 (2.30)	0.22 (7.29)	0.02 (2.63)	0.05 (5.46)	0.16 (5.27)
Perceived level of information	0.10 (6.71)	0.24 (7.65)	-	0.15 (6.11)	-	0.18 (5.46)	0.13 (4.14)	0.02 (2.17)	0.27 (7.53)	0.03 (2.87)	0.08 (5.63)	0.09 (5.66)
CCS awareness	-	0.05 (3.85)	-	0.09 (5.74)	-0.14 (-4.08)	0.13 (3.73)	-0.10 (-3.10)	-0.11 (-3.48)	0.04 (3.25)	-0.10 (-3.05)	-	0.08 (5.63)
Total effects on perceptions towards potential personal benefits of using CCS technology in own region												
Access to information	0.19 (8.48)	0.27 (9.97)	0.10 (3.23)	0.12 (9.20)	-	0.18 (6.92)	0.12 (4.50)	0.06 (5.47)	0.23 (8.95)	0.08 (5.92)	0.13 (7.83)	0.12 (8.31)
Perceived level of information	0.20 (7.34)	0.22 (7.12)	0.13 (4.21)	0.20 (7.99)	0.22 (8.73)	0.20 (6.20)	0.16 (5.88)	0.11 (4.83)	0.39 (13.55)	0.20 (6.25)	0.21 (7.26)	0.39 (14.24)
CCS awareness	0.33 (12.61)	0.27 (10.02)	0.28 (10.43)	0.24 (10.96)	0.13 (5.31)	0.16 (6.87)	0.24 (8.75)	0.19 (5.91)	0.24 (8.80)	0.24 (7.60)	-	0.36 (13.74)
Total effects on CCS awareness												
Access to information	0.31 (11.63)	0.25 (7.78)	0.21 (6.91)	0.28 (11.88)	0.10 (6.80)	0.28 (9.22)	0.16 (5.04)	0.22 (6.92)	0.16 (7.73)	0.16 (5.19)	0.27 (8.68)	0.08 (6.56)
Perceived level of information	0.27 (9.04)	0.23 (6.33)	0.22 (6.21)	0.35 (13.00)	0.26 (7.84)	0.35 (9.39)	0.29 (8.35)	0.27 (7.87)	0.40 (13.07)	0.28 (8.41)	0.19 (5.82)	0.27 (8.56)

* Only statistically significant effects are presented.

This study aims to provide some information on the relationship between climate change attitudes/ perceptions and information/ awareness issues, amongst other determinants, in the European Union. As access to and perceived level of information together with CCS awareness were found to significantly influence CCS preferences, this might suggest the need for the European Union to invest more in enhancing the climate change information available to the public and improving access to it through measures such as climate change education campaigns. In recent years the amount of information on climate change issues available to public has increased considerably, however there is a need for 'ample, clear, sufficiently strong, and consistent signals' (Moser, 2010; Best-Waldhobera & Daamena, 2011).

There is an increasing amount of research on carbon dioxide (CO_2) emissions and sinks, however the level of knowledge and information that the average citizen has on the topic is low. Climate change mitigation decision-making should involve participation at all levels and the public should have a say in the process. As CO_2 capture and storage (CCS) is an essential climate change mitigation technology, policy-makers should ensure an efficient knowledge transfer to the public and subsequently facilitate their informed response.

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