Carbon Pricing and Redistribution

A quantitative analysis of attitudes towards carbon taxation

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Contents

Introduction

Carbon taxation is a contested topic in recent academic and political debate. While some actors focus on pointing out its potential shortcomings, others emphasize the potential this instrument has to offer.

In Europe, carbon taxation has been subjected to high stakes before being introduced. Courts have repeatedly stopped legislation aimed at introducing such taxes[1], and widely differing models have been discussed. In Germany, recently passed legislation - which introduced a carbon price of 10€ per ton in 2021, has been criticised as insufficient.

Introducing carbon pricing has potential benefits on two sides: It emphasizes potential polluters or consumers to pollute less by adding a price tag to otherwise externalized costs, and raises funds for mitigation measures[2].

However, different socio-economic groups are impacted differently by alternating models of carbon pricing[3]. A tax on goods, for example, impacts lower income households disproportionately higher compared to higher income households, while an income-based tax promises a more proportional impact.

In order to introduce respective legislation in democratic systems, sufficient public support is required. Therefore, this paper tries to contribute to ongoing research by asking the question:

"Are there significant differences between socio-economic groups regarding their perspective on individual carbon pricing?"

To answer this question, a survey was conducted among German-speaking Europeans above the age of 16.

After analysis, no significant relation between level of formal education and general support for carbon taxes was found. There was also no significant relation between level of income and preferred taxation model in generally supportive individuals.

[1] (Bundesverfassungsgericht 2017; Die Presse 2009)
[2] Besser formulieren
[3] (Liang, Wang, and Wei 2013)

Theory

Carbon Tax Designs

There are multiple ways to implement carbon pricing. For example, emission trading systems have been introduced in different parts of the world, most notably for the European Union. These systems have proven successful in reducing emissions partially[4], but are not sufficient to solve the problem alone and have their own set of issues[5].

This paper is looking at an instrument with a more direct approach: Carbon taxes. Traditional models of carbon taxes work by utilizing two effects. These effects are:

1. Internalisation of costs by adding a price to emissions and products which cause emissions, thus incentivising "cleaner" alternatives.
2. Usage of generated revenue for the prevention or reduction of emissions, or for mitigation efforts[6].

This model, described as a *"cost effective economic instrument"* by the World Bank[7], has been criticised for its potential to place a higher burden on socio-economic groups with lower income[8]. While everyone would pay the same tax for the same goods and services, the share of taxes paid compared to available income would be higher for those with lower income. At the same time, those groups are generally responsible for a smaller part of carbon emissions[9]. Also, it would likely require differing tax rates, depending on the products taxed, since those vary in terms of pollution caused. This would make the whole approach more bureaucratic and harder to achieve politically.

Another model of taxation could partially solve this problem. This model would introduce a tax based on income, rather than on goods and services. The decoupling of emissions and taxation might be seen as a potential problem with this approach. However, scholars suggest that higher-income individuals are generally responsible for a higher share of emissions, therefore weakening this argument.[10] Additionally, research from Maestre-Andrés et al links public support and perceived fairness, thus making an argument for a redistributive dimension of carbon taxes[11].

Variation between socio-economic groups

This paper will analyse two dimensions of carbon pricing:

1. Overall support of carbon taxes in relation to education

2. Support for specific models of carbon taxation, by generally supportive individuals, in relation to income

The first dimension was analysed because statistics of recent election in Germany and Austria have shown a connection between more advanced levels of education formal and an electoral preference

[4] (Elgie and McClay 2013)
[5] (Matthes 2017)
[6] (World Bank n.d.)
[7] (World Bank n.d.)
[8] (Speck and J.L.R.Proops 2000)
[9] (Gore 2020; Budgetdienst - Parlamentsdirektion Republik Österreich 2019)
[10] (Gore 2020)
[11] (Maestre-Andrés, Drews, and Bergh 2019)

towards Green parties[12]. These parties have carbon pricing as one of their core policies. Therefore, testing for a connection between levels of education and support for carbon taxation could yield results which could be used to further analyse electoral performance of green parties.

The second dimension was analysed because it might produce relevant results in distributional policies. Higher income individuals were expected to support a tax on goods and services rather than on income, because a tax on goods and services would impact them less economically[13]. At the same time, lower income respondents were expected to lean towards supporting a carbon tax model based on income, which they might perceive as fairer.

These socio-economic groups were analysed because their opinion on carbon taxation might be an indicator towards the potential such policies have in the electoral arena.

Hypotheses

The following hypotheses were tested:

H1 *"Individuals with higher education are more likely to support carbon pricing."*

H2 *"Higher income individuals are more likely to support flat carbon pricing models, while generally supportive lower income individuals are more likely to support income-based models."*

For each of those hypotheses, the negation equals H0.

[12] (DerStandard 2019; Caspari 2017)

[13] (Budgetdienst - Parlamentsdirektion Republik Österreich 2019)

Methodology

Target Population

The target population were German-speaking Europeans above the age of 16. This age was chosen because it entitles citizens to take part in elections, and therefore decide on future policies, including carbon pricing[14].

Dependent Variables and Operationalisation

There were two dependent variables, which were formulated to test both hypotheses: The first one measured general support for carbon taxation, the second one measured support for specific pricing models. The first DV was used to test hypothesis H1, the second was used to test hypothesis H2.

To measure general support of carbon taxation, respondents were asked:
"Wie bewerten Sie die folgende Aussage? 'Ich würde die Einführung einer CO2-Steuer unterstützen, auch wenn diese meine Lebenserhaltungskosten erhöht.'" (Code B1.SQ001)

Answering was possible on a likert-scale containing 5 steps, coded 1-5. 1 equalled complete support, while 5 equalled complete opposition.

To measure support for specific pricing models, respondents who had answered B1.SQ001 with 1 or 2 [15] were shown the question:

"Welche Art einer CO2-Steuer würden Sie unterstützen?" (Code B2)

This question introduced two different models, as derived from the previous chapter "Theory". These models are based on goods and services (Code 1) or income-based (Code 2). The possible responses were *„Eine CO2-Steuer auf Waren und Dienstleistungen"* (Code 1) and *„Eine CO2-Steuer auf Einkommen"* (Code 2). Respondents who did not show support of carbon taxation were not shown this question, and coded as Code 3.

Independent Variables

Independent Variables used were the level of education measured by asking for the highest achieved academic grade (Code E4) and the monthly income after tax (Code E3). Income was measured in brackets, which are visible in table 1. In order to be viable, these brackets were ranked in R.

Demographic data concerning gender, age and occupation was also collected to be potentially used as a control variable.

Data Collection

The data was collected in a survey, which was conducted online between the 8th of February 2021 and the 14th of February 2021. The questions and layout were programmed in the *LimeSurvey* tool.

The survey contained 26 Questions, however, not all of those were relevant for this study. The other questions originated from other students, and were bundled together for easier distribution of surveys. The whole survey was conducted according to standards set by the European Union's *General Data Protection Regulation*, and responses were anonymized. Respondents had to agree to

[14] in countries with a high anticipated participation in the survey, namely Austria and Germany
[15] = supportive regarding carbon pricing

LimeSurveys and the University of Innsbruck's data protection policies before being able to participate.

Quality Control

For reasons of quality control, all respondents who took less than 120 seconds[16] to complete the questionnaire were omitted from the dataset before analysis occurred. Additionally, only completed questionnaires were analysed. From the total of 102 responses, 86 remained for further analysis.

In the analysis, the regression models were fitted with additional demographic control variables to avoid spurious correlations. These were age (E2) and occupation (E5).

Respondents were only able to continue to the next question if they provided an answer.

Analysis

Descriptive analysis was done using the "short-statistics" , which were automatically generated by *LimeSurvey*[17].

The hypotheses were tested in R using a script written by the author.[18] The significance level was set at 5%.

The first pair of dependent and independent variables (general attitude towards carbon taxation and level of formal education) was tested for correlation using the Spearman correlation test. This test was chosen because both variables were ordinal scaled. The second pair (preferred model of carbon taxation and income level) was tested for correlation using the Pearson correlation test.

A multiple linear regression model was then used to test each hypothesis and associated pair of IV and DV. Support for carbon taxation was treated as an interval scaled variable for this test.

[16] Code "interviewtime"
[17] Available at https://github.com/Enklus/SoSciMethod , filename "short statistics.pdf"
[18] Available at https://github.com/Enklus/SoSciMethod , filename "script.R"

Findings

Descriptive Analysis

Out of all the respondents, 49 identified as male (56.98%), 35 as female (40.7%) and 2 as diverse (2.33%). This gender distribution was different from the target population, where women where a slight majority[19], indicating a bias towards male respondents.
The average age was approximately 28 years, with 22 years being the lower and 26 years being the upper quartile. This mean is nowhere near the mean of European countries with large German-speaking populations, like Germany (46 years), Austria (43 years), or Italy (44 years)[20].
Levels of formal education were also generally higher than in the general population[21].
Notably, income groups were not distributed like in the general population[22]. The largest group was made up of respondents having access to 0-500€ per month (Code 1), the second-largest group had access to 751 - 1.000€ per month (Code 2). These two groups made up almost half of all respondents. A look at the occupational statistics (E5) offers a possible explanation: 52.33% of the participants were students.[23]
When looking at the responses to B1.SQ001, the level of overall support was noteworthy. More than 58% of all respondents were at least partially in support of carbon taxation[24]. This differs greatly from overall public support for this policy, which is below 50%[25].

Of those supporting carbon taxes at least partially, 90% supported a tax on goods and services, while 10% supported a tax based on income[26].

Correlation Analysis

When the level of formal education (E4) and attitude towards carbon taxation (B1.SQ001.) were analysed using a Spearman correlation test, no significant effect was found. The same occurred for the test of income level (E3) and preferred taxation model (B2) using the Pearson correlation test.

Regression Analysis

After regression analysis, the following results were found:

First, there was no statistically significant connection between level of education and support for carbon taxation.[27] Also, no other control variables influenced the result in a significant way. Therefore, Hypothesis H1 was discarded, and the following adapted: *"There is no statistically significant relation between the level of education and support for carbon taxation."*

[19] (Statistisches Bundesamt 2020)
[20] (Worlddata.info 2021)
[21] See figure 1.
[22] See table 1.
[23] See figure 3.
[24] See table 4.
[25] (Umit and Schaffer 2020)
[26] See table 5.
[27] See table 2 .

Second, there was also not statistically significant connection between income and the support of specific models of carbon taxation.[28] No other control variables influenced the result in a significant way[29]. Therefore, Hypothesis H2 was discarded, and the following adapted: *"There is no statistically significant relation between the level of income and support for specific models of carbon taxation in individuals which were in favour of carbon taxation."*

Potential sources of error

The most important potential sources of error were the small sample size (n=86) and the potential bias in sampling. Sampling was not done in a truly random manner. Instead, the survey was distributed amongst other students and family or friends of the survey's creators, which increased the likelihood of certain socioeconomic groups[30] to take part in the survey, while decreasing the likelihood for other groups. This was evident while observing demographic data on respondents.

Both questions concerning carbon taxation were rather simplistic to ensure comprehension across all respondents. This simplistic nature might be problematic because different respondents might interpret the underlying concepts differently.

Another problem arises from the assumption that those who participated were entitled to vote. Participants might have been German-speaking citizens of other states, invalidating the results.

Also, an unexpectedly high number of respondents were residents of neither Austria nor Germany[31]. This is problematic, because these respondents might not be eligible to vote in their country at all.

In addition, the survey was conducted online, which might have restricted access for parts of the population without access to the internet, or for those without the necessary know-how.

[28] See table 3.
[29] Except for the group which chose "other" when asked for their highest level of education. However, this cannot be properly interpreted, as this group was made up of only one respondent.
[30] Like other students or academics
[31] See figure 2.

Conclusion

In conclusion, no statistically significant claims about the relation between education and support for carbon taxation, or income and support for specific models of carbon taxation can be made. Therefore, the research question *"Are there significant differences between socio-economic groups regarding their perspective on individual carbon pricing?"* must be answered negatively in the context of this paper.

Even if this survey had produced significant results, their validity might be questionable. This is caused by the rather vague manner in which questions regarding carbon tax were formulated.

A large-scale survey using a similar methodological approach could potentially yield vastly different results, because true random sampling would then be possible. However, questions might need to be rephrased beforehand, and proper definitions of carbon tax models would have to be given to respondents. In addition, weighting mechanisms might need to be employed to counter bias introduced by the method of survey distribution and survey conduction.

In terms of the theoretical approach, the author would like to also shine light on the possibility of a carbon tax on goods and services with a redistributive aspect, called the "climate bonus" (*"Klimabonus"*). This could combine the positive effects of a tax on products associated with emissions, while still retaining a "fair" component. The results for the preferred model of carbon taxation, if interpreted despite the survey's shortcomings, also suggest that this model might achieve higher electoral support than the model which was based on income.

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Parts of the R code used were derived from Code provided by Sarah Behrens in the "Seminar Survey Methodology in Social Policy Research" (Code: 402151) at the University of Innsbruck. Additionally, parts of the code were discussed with members from my research group; namely Otto Dürr, Patrick Bergamo and Raphael Wibmer.

R code, LimeSurvey "short statistics", Codebook and dataset can be accessed at https://github.com/Enklus/SoSciMethod .

Appendix

Tables

Table 1: Distribution of income groups, sourced from LimeSurvey “short statistics”

Wie viel Geld haben Sie im Monat nach Steuern zu Verfügung?

Antwort	Anzahl	Prozent
0 - 500 € (1)	23	26.74%
501 - 750 € (2)	6	6.98%
751 - 1.000 € (3)	16	18.60%
1.001 - 1.250 € (4)	7	8.14%
1.251 - 1.500 € (5)	9	10.47%
1.501 - 1.750 € (6)	11	12.79%
1.751 - 2.000 € (7)	8	9.30%
mehr als 2000 € (8)	6	6.98%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Table 2: Results of regression analysis of dependent variable B1.SQ001. with independent variable E4

	Dependent variable:
	B1.SQ001.
education-Matura/Abitur	-0.072
	(0.792)
education-Bachelor or EQUIV	0.284
	(0.826)
education-Master or EQUIV	0.418
	(0.889)
education-other post-secondary	0.984
	(1.141)
education-other	-0.177
	(1.434)
E2	-0.028*
	(0.016)
E3	0.003
	(0.101)
occupation-Studierender	-0.871
	(0.843)
occupation-Berufstätiger	-0.097
	(0.929)
occupation-Arbeitssuchender	-1.042
	(1.119)
Constant	3.704***
	(0.877)
Observations	86
R^2	0.129
Adjusted R^2	0.013
Residual Std. Error	1.245 (df = 75)
F Statistic	1.110 (df = 10; 75)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 3: Results of regression analysis of dependent variable B2 with independent variable E3

	Dependent variable:
	B2
income.L	-0.100
	(0.241)
income.Q	-0.200
	(0.148)
income.C	-0.041
	(0.131)
income4	-0.193
	(0.152)
income5	0.276*
	(0.160)
income6	-0.075
	(0.142)
income7	-0.152
	(0.140)
education-Matura/Abitur	0.134
	(0.283)
education-Bachelor or EQUIV	0.245
	(0.297)
education-Master or EQUIV	0.315
	(0.307)
education-other	1.197***
	(0.429)
E2	0.005
	(0.005)
E3	
occupation-Studierender	-0.026
	(0.344)
occupation-Berufstätiger	-0.195
	(0.361)
occupation-Arbeitssuchender	-0.292
	(0.351)
Constant	0.872**
	(0.336)
Observations	50
R^2	0.392
Adjusted R^2	0.124
Residual Std. Error	0.284 (df = 34)
F Statistic	1.464 (df = 15; 34)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 4: Overall responses to B1.SQ001. Sourced from LimeSurvey “short statistics”.

Wie bewerten Sie die folgende Aussage? Ich würde die Einführung einer CO2-Steuer unterstützen, auch wenn diese meine Lebenserhaltungskosten erhöht.

Antwort	Anzahl	Prozent
Stimme voll und ganz zu (1)	24	27.91%
Stimme eher zu (2)	26	30.23%
Unentschieden (3)	12	13.95%
Stimme eher nicht zu (4)	20	23.26%
Stimme gar nicht zu (5)	4	4.65%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Table 5: Overall responses to B2. Sourced from LimeSurvey “short statistics”.

Welche Art einer CO2-Steuer würden Sie unterstützen?

Antwort	Anzahl	Prozent
Eine CO2-Steuer auf Waren und Dienstleistungen (1)	45	52.33%
Eine CO2-Steuer auf Einkommen (2)	5	5.81%
Keine Antwort	0	0.00%
Nicht gezeigt	36	41.86%

Figures

Figure 1: Distribution of highest level of formal education. Own plot

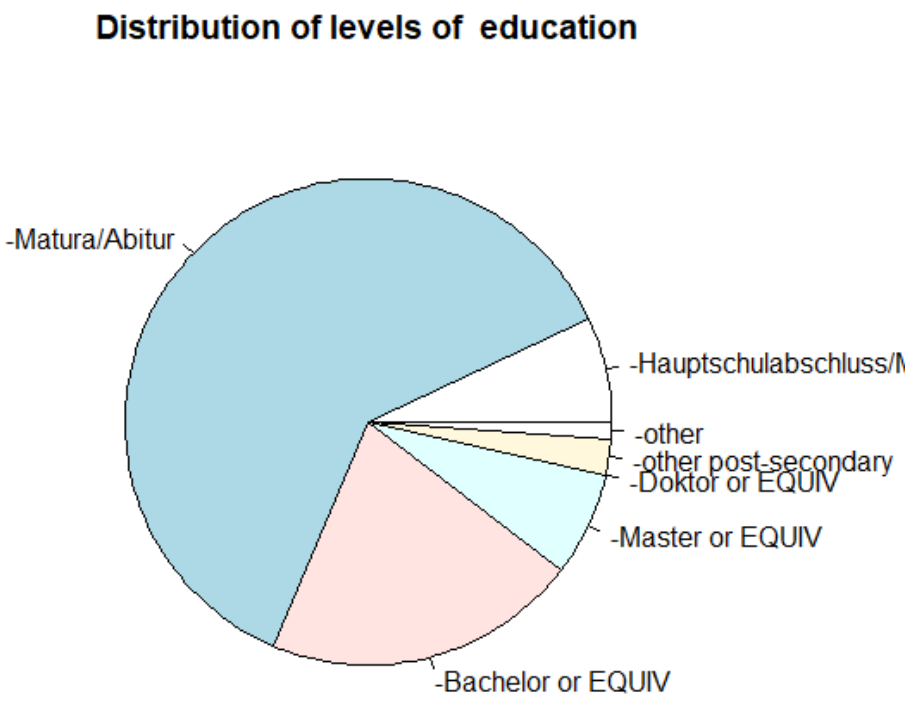

Figure 2: Country of permanent residence. Sourced from LimeSurvey “short statistics”.

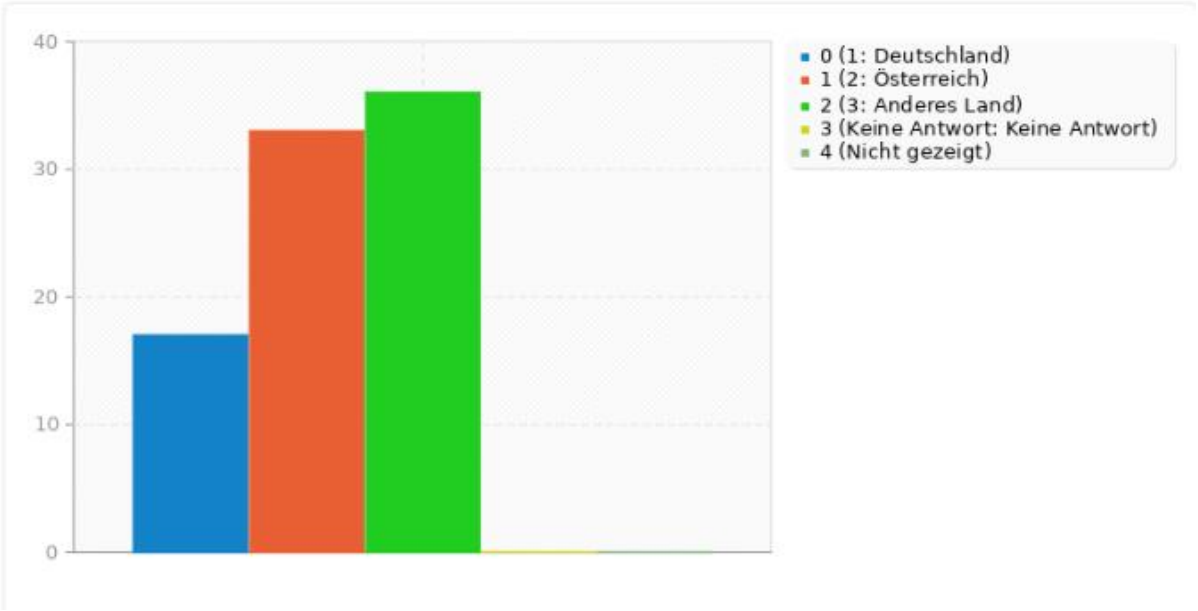

Figure 3: Distribution of occupation. Own plot.