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WHO IS GOING TO PAY FOR ALL THIS CO_2?

DISTRIBUTIONAL EFFECTS OF CARBON PRICING IN ROMANIA AND BULGARIA

AUTHOR

VLAD SURDEA-HERNEA,
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SUPERVISORS

DR. CHRISTIAN FLACHSLAND
DR. MICHAEL PAHLE

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ABSTRACT

This thesis evaluates the vertical and horizontal distributional effects of carbon pricing in Romania and Bulgaria. By designing a series of static microsimulations, I prove that carbon pricing is regressive before government redistribution, regardless of the level of taxation. However, I also show that by choosing an optimal revenue-recycling strategy, authorities in both countries can assure tax neutrality, and even progressivity. In this sense, two revenue-recycling schemes are analyzed: a lump-sum transfer, and a normative transfer derived from Rawlsian principles. The lump-sum transfer partially alleviates regressivity in both countries, while the Rawlsian transfer makes carbon pricing progressive in Romania, and neutral in Bulgaria. Finally, by conducting a series of semi-structured interviews with experts from Eastern Europe, I assess the viability of the Rawlsian transfer. The main finding is that implementing the Rawlsian revenue-recycling scheme could be achieved if governments frame it as a response to energy poverty concerns, thus avoiding backlash against expansive welfare policies.

KEY POLICY INSIGHTS

- Prior to revenue-recycling, carbon pricing is regressive in both Romania and Bulgaria, disproportionately affecting people from lower-income deciles and carbon-intensive regions.
- The optimal solution would be implementing a Rawlsian-inspired transfer that assures the neutrality of carbon pricing, while also being easy to design and oversee.
- To justify the implementation of the Rawlsian transfer, authorities should frame this revenue-recycling scheme as a direct response to energy poverty concerns, and not as a social welfare measure.

KEYWORDS

Carbon pricing; distributional effects; energy poverty; Eastern Europe; John Rawls

GRAPHICAL ABSTRACT

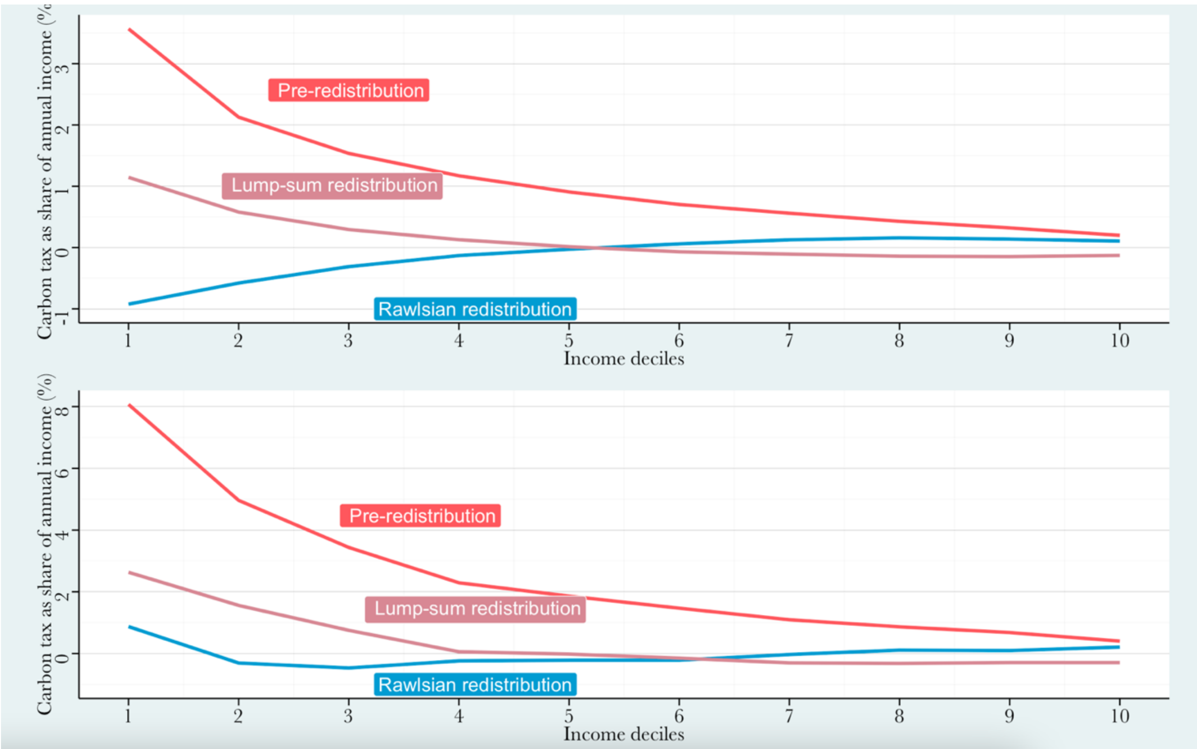

Figure 1. Graphical Abstract — distributional effects of carbon pricing in Romania (upper side) and Bulgaria (lower side). The red line displays the incidence of a EUR 12/tCO_2 carbon tax prior to redistribution, while the pink and blue lines display the incidence of the same tax after either a lump-sum redistribution scheme, or a Rawlsian-inspired redistribution scheme respectively.

LIST OFF ABBREVIATIONS

CBAM	Carbon border-adjustment mechanism
CEE	Central and Eastern Europe
CO_2	Carbon Dioxide
COICOP	Classification of Individual Consumption by Purpose
EC	European Commission
EE	Eastern Europe
EGD	European Green Deal
EU	European Union
EU ETS	European Union Emissions Trading Scheme
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GTAP	Global Trade Analysis Project
INDC	Intended Nationally Determined Contribution
LSDV	Least-Square Dummy Variable
LULUCF	Land Use, Land Use Change and Forestry
MRIO	Multi-Region Input-Output
NDC	Nationally Determined Contribution
NUTS	Nomenclature of Territorial Units for Statistics
NGO	Non-governmental Organization
SDG	Sustainable Development Goal
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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1. INTRODUCTION

1.1. Background

Scientists established that the accumulation of anthropogenic GHGs emissions in the atmosphere induces enduring effects on Earth's climate system (Allen et al., 2009; Council, 2011; IPCC, 2013, 2018). Effects include upsurges in the intensity and frequency of extreme weather events, irreversible damage to ecosystems, and the alteration of the cryosphere (Adler et al., 2019; Basto et al., 2018; Frölicher et al., 2018; Jentsch & Beierkuhnlein, 2008; McGregor et al., 2005; Nunez et al., 2019; Tang et al., 2014; Vuille et al., 2018).

Given the magnitude of the crisis, parties to the UNFCCC reached the Paris Agreement, intending to limit global warming to well below 2°C compared to pre-industrial levels (Ourbak & Tubiana, 2017). To achieve this, the European Commission proposed the European Green Deal, a strategy aiming to make Europe carbon-neutral by 2050 (European Commission, 2019). Being EU's cornerstone policy in combating climate change, it is expected that the price of carbon in the EU ETS will rise accordingly (Elkerbout et al., 2020). However, while indispensable to avoid further tipping points in Earth's climate system (I. Parry, 2020), carbon pricing has significant distributional repercussions, disproportionately affecting the least well-off in society (Ohlendorf et al., 2021; Peñasco et al., 2021).

One EU region to be most affected by the surge of carbon pricing is Eastern Europe. EE has been historically reticent towards ambitious climate policy due to the high levels of poverty and wealth inequality (Alam et al., 2005; Milanovic & Ersado, 2012; Nunez et al., 2019). These circumstances, as well as the lack of previous research in the field, elicit the importance of understanding the social effects of carbon pricing in EE (Jentsch & Beierkuhnlein, 2008), to avoid potential backlash against the green transition (M. J. Dorsch et al., 2020).

1.2. Case selection

I study two representative countries for EE: Romania and Bulgaria (Jiroudková et al., 2015). They have been selected following a loose application of *Mill's Method of Difference* (Anckar, 2008; Berg-Schlosser & De Meur, 2009). This choice rests upon the assumption that Romania and Bulgaria are homogenous in terms of demographics and socio-economic characteristics, enabling the study of differences in the distributional effects of carbon pricing without the fear of confounding (Table 1)

	ROMANIA	**BULGARIA**
POPULATION DENSITY	84/km2	64/km2
SHARE OF URBAN POPULATION	54.6%	75.6%
AVERAGE GDP PER CAPITA	EUR 10.672	EUR 9.272
AVERAGE NET WAGE	EUR 701/month	EUR 554/month
AVERAGE PER CAPITA GHGS EMISSIONS	3.98 tCO_2/cap	7.11 tCO_2/cap
GINI INDEX	36.0	40.4

Table 1. Comparative outlook of Romania and Bulgaria

1.3. Research question

I ask the following research question: What are the vertical and horizontal distributional effects of carbon pricing in Romania and Bulgaria?

- To analyze vertical distributional effects, I study the effects of carbon pricing across income groups in Romania and Bulgaria.
- To analyze the horizontal distributional effects, I scrutinize the effects within income groups, differentiated by geographic distribution at the regional level (NUTS2).

I hypothesize that in the absence of targeted revenue-recycling schemes, carbon pricing is regressive in both countries.

Furthermore, I analyze which revenue-recycling mechanisms reduces the regressivity of carbon pricing while also retaining as much social welfare gain. More specifically, I propose two mechanisms:

- A lump-sum rebate, under which the revenues obtained from the carbon tax are payed back in equal shares to the entire population.
- A Rawlsian-inspired transfer, under which the revenues obtained from the introduction of the carbon tax are distributed, in equal shares, to households most affected by the tax.

While this is ultimately a constrained optimization problem, welfare economics analysis is beyond the scope of this thesis. As such, I develop only a succinct qualitative evaluation.

The complete causal mechanism explored in this thesis is illustrated in the directed-acyclic graph from Figure 2. The complete relationship between different variables will be explored in subsequent chapters.

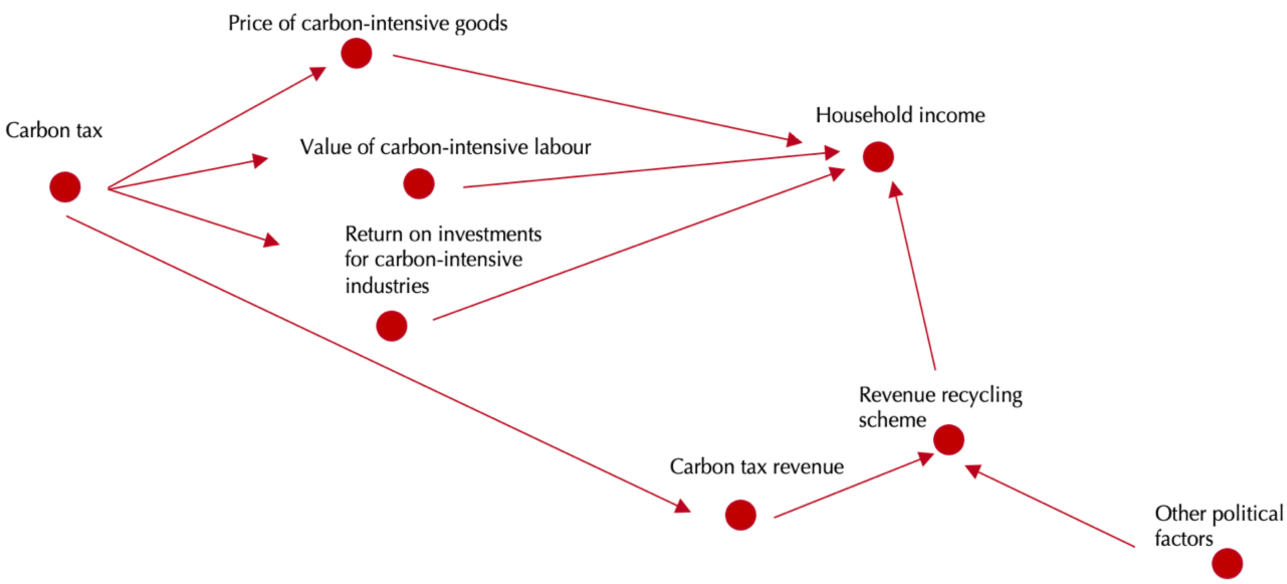

Figure 2. DAG representing the causal mechanism studied in this thesis

1.4. Contributions

I intend to fill three existing gaps in the literature:

1. While there are multiple studies on the distributive effects of carbon pricing, none focus on EE. This is problematic because EE is the least affluent region of the EU, making it the place where carbon pricing could have the biggest impact.
2. While papers discuss the implications of vertical inequities resulting from carbon pricing, few papers address horizontal equity. I use an original imputation strategy to incorporate horizontal effects, overcoming poor data quality.
3. Few papers discuss how policymakers should implement carbon pricing under uncertainty. The proposed Rawlsian-inspired framework offers a normative solution to this challenge, potentially contributing to the process of capacity building in Romania and Bulgaria.

1.5. Structure

The rest of the thesis is structured as follows:

- Chapter 2 summarizes the literature on carbon pricing and its distributional effects, discussing different revenue-recycling schemes.
- Chapter 3 explains the political economy of carbon pricing in Romania and Bulgaria, as well as introduces the proposed Rawlsian transfers.
- Chapter 4 explores the datasets and presents the methodological setup.
- Chapter 5 presents the results of the micro-simulations and evaluates them in a comparative manner.
- Chapter 6 enables a further discussion based on the semi-structured interviews conducted with experts from EE.
- Chapter 7 presents the concluding remarks.

2. LITERATURE REVIEW

2.1. The logic of carbon pricing

Carbon pricing is a policy tool that captures the costs of GHG emissions by linking them to their source of production through a mandatory price (Boyce, 2018; Ramstein et al., 2019). The functioning of carbon pricing is contingent on the assumption that climate change is the consequence of an externality (Nordhaus, 2019; Stern, 2006): parties responsible for emissions do not pay the full social costs of GHG accumulating in the atmosphere, passing them to communities (Aldy & Stavins, 2012).

Figure 3 shows how the discrepancy between the social costs and the private costs in the case of the climate externality leads to the actual equilibrium being different from the Pareto-efficient equilibrium, causing deadweight losses for the society.

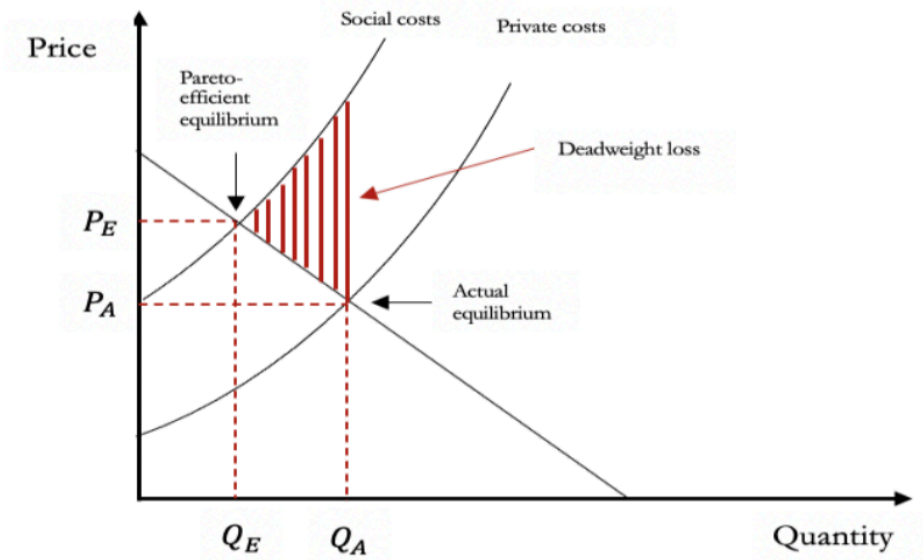

Figure 3. The climate externality

Theoretically, preventing such market failures is achieved by assigning property rights (Devlin & Grafton, 1998) that foster the development of complete markets (Coase, 2000; Jackson & Jabbie, 2019). However, given that climate elements are public goods (Grasso, 2004), property rights are difficult to assign without significant transaction costs (Coggan et al., 2010). The absence of property rights implies, thus, a lack of complete markets for environmental amenities, leading to inefficient usage (A. L. Bovenberg & Goulder, 2001; Pelman et al., 2011).

One solution is imposing a Pigouvian tax on externality-generating activities (Atkinson & Stern, 1974; Baumol, 1972; Pigou, 1960). While the literature on the optimal taxation of externalities is evolving, economists generally support corrective taxation as being the optimal policy strategy (Acemoglu et al., 2012; A. L. Bovenberg, 1999; A. L. Bovenberg & De Mooij, 1994; Cremer et al., 1998; H., 1995; I. W. H. Parry, 1997; van den Bijgaart et al., 2016).

In spite of that, taxes on carbon tend to be regressive, disproportionally affecting households from lower-income parts of the population, and from regions more dependent on carbon-intensive industries (Hassett et al., 2009; Liang & Wei, 2012; Vandyck & Van Regemorter, 2014). The importance of addressing the regressive nature of carbon pricing is derived both from equity concerns (Klenert et al., 2018) and from the need to prevent the escalation of opposition to climate action (M. J. Dorsch et al., 2020; Levi, 2021; Levi et al., 2020). These effects are further explored in Section 2.2.

Literature shows that governments can mitigate these effects through redistributing the revenues generated by the carbon taxes (Beck et al., 2015; Roach, 2021). These revenue-recycling schemes are further explored in Section 2.4, while their moral justification is detailed in Section 2.3.

2.2. Distributional effects of carbon pricing

Carbon pricing raises energy prices and, therefore, the percentage of income households spend on energy consumption and complementary goods and services (Dorband et al., 2019). It also affects the production of carbon-intensive goods dependent on fossil fuels (OECD, 2015). Finally, carbon pricing affects the income of workers employed by companies producing carbon-intensive goods, as well as the returns on investment of these companies (Arlinghaus, 2015). On the other hand, these effects are not static, as they incentivize households to switch to cleaner alternatives, and companies to pursue technological change (Fullerton & Heutel, 2007, 2011).

The literature finds that the distributional impacts of carbon pricing are dependent on the elasticity of the carbon-intensive goods, services and labor (Grainger & Kolstad, 2010; Rausch et al., 2011; Steininger et al., 2014). Therefore, when designing a carbon tax, policymakers should account for how costs and benefits are distributed across society (A. Bovenberg & Goulder, 2001; Dinan & Rogers, 2002).

Ignoring revenue-recycling effects, carbon pricing is found to be regressive in industrialized countries, by using a diverse set of methods (Berry, 2019; Brännlund & Nordström, 2004; Bureau, 2011; Conefrey et al., 2013; Crowley, 2013; Hassett et al., 2009; Kerkhof et al., 2008; I. W. H. Parry, 2004; Pashardes et al., 2014; Sajeewani et al., 2015; Speck, 1999; Tiezzi, 2005; Tovar Reaños & Wölfing, 2018; West & Williams, 2004; Wier et al., 2005; Williams et al., 2015) (Table 2[1]).

REFERENCE	**REGION**	**MODEL**	**RESULTS**
BENTO ET AL. (2009)	USA	CGE	Regressive
BOYCE (2018)	USA	Literature review and imputation	Regressive
CALLAN ET AL. (2009)	Ireland	CGE	Regressive
HAMILTON AND CAMERON (1994)	Canada	I/O + CGE	Regressive

[1] This table has been compiled by analyzing the results of the most relevant papers computing the distributional effects of carbon pricing. The papers were pre-selected by using the keywords "distributional effects of carbon pricing" on Google Scholar, and then a list with the most cited papers was compiled automatically, using R. Lastly, I have selected a sample of diverse industrialized countries for Table 2.

LABANDEIRA AND LABEGA (2004)	Spain	I/O + AIDS estimation	Regressive
TIEZZI (2001)	Italy	AIDS estimation	Regressive
BRANLUND AND NORDSTROM (2004)	Sweden	AIDS estimation	Regressive
WIER ET AL. (2005)	Denmark	CGE	Regressive
KERKHOF ET AL. (2008)	Netherlands	I/O estimation	Regressive
VAN HEERDEN ET AL. (2006)	South Africa	CGE	Progressive
SCOTT AND EAKINS (2004)	Ireland	CGE	Regressive
CREEDY AND SLEEMAN (2006)	New Zeeland	I/O estimation	Regressive
DISSOU AND SIDDIQUI (2014)	Canada	CGE	Regressive
DOUENNE (2020)	France	QUAIDS estimation	Regressive
BUREAU (2011)	France	Statics microsimulations	Regressive
REAÑOS AND WÖLFING (2018)	Germany	EASI estimation	Regressive
BERRY (2019)	France	Static microsimulations	Regressive
BOHRINGER ET AL. (2017)	Germany	CGE + microsimulations	Regressive
JAKOB (2020)	Germany	I/O estimation	Regressive

Table 2. Distributional effects of carbon pricing

2.3. Equity concerns in climate policy

As distributional concerns are questions of fairness (Markandya, 2011), it is essential to comprehend the ethics of climate action (Fullerton & Heutel, 2011; Klinsky et al., 2017; Tol et al., 2003). This inter-disciplinary approach is in line with the EU's vision of the European green transition being a just transition (Galgóczi, 2020; Sabato & Fronteddu, 2020).

The literature distinguishes between horizontal and vertical equity (Fischer & Pizer, 2019; McDaniel & Repetti, 1992), with both dimensions being essential for socially-just climate policymaking (Blonz et al., 2011; Fullerton et al., 2019). Vertical equity refers to the appropriate pattern of differentiation between groups of unequal individuals (Lambert, 1992), while horizontal equity refers to the equal treatment of groups of equal individuals (Kaplow, 1985; Musgrave, 1990) 3). Table 3 briefly describes the moral foundations for both types of equity.

	VERTICAL EQUITY	**HORIZONTAL EQUITY**
WHAT IS THIS FORM OF DISTRIBUTIVE JUSTICE BASED ON?	Principle of diminishing marginal utility of income and wealth – the additional utility a person derives from a given unit-increase of their wealth diminishes with every unit-increase in the wealth that they already have.	Principle of "equal sacrifice", implying that people with the same income level should have the same burden towards achieving a social objective.
KEY REFERENCES	(Metcalf, 1999; Williams et al., 2015); (Kaplow, 1985; Musgrave, 1990)	Elkins (2006); Plotnick (1982); Weinzierl (2014, 2018)

Table 3 Distributive Justice in Climate Policy

2.4. Revenue-recycling

To effectively analyse the distributional effects of carbon pricing, it is essential to understand how governments spend the respective tax revenues (Bowen, 2015; I. W. H. Parry, 1995). Different revenue-recycling mechanisms have different implications for the two equity dimensions (Klenert et al., 2018; Klenert & Mattauch, 2016). Thus, a socially optimal revenue-recycling scheme can lead to the long-term viability of carbon pricing, as it can incorporate the interests of heterogenous agents, preventing backlash (Baranzini et al., 2017; M. J. Dorsch et al., 2020; Kallbekken et al., 2011). The main types of revenue-recycling (Haug et al., 2018), are described in Tables 4:

	DIRECT TRANSFER	TAX INCENTIVES
PRINCIPLE BEHIND REVENUE REDISTRIBUTION	The atmosphere is held in common by all individuals, with the government serving as a trustee of this resource (Barnes, 2001).	Taxation is by default distortionary, so if carbon pricing is introduced, the new revenue stream could be used to eliminate other distortionary taxes.
ADVANTAGES	• Mitigates the regressivity of a carbon tax (Boyce & Riddle, 2007; Burtraw et al., 2009; Klenert & Mattauch, 2016). • Potentially no distortionary effects on the market (Mirrlees & Adam, 2010; Poterba, 1991).	• Reduces frictions in the overall tax system. • Might be more effective from a social welfare perspective (Haug, 2018).
DISADVANTAGES	• Inefficient from a social welfare perspective (Parry, 2015).	• Potentially augments the regressivity of carbon pricing (Mathur & Morris, 2014; I. Parry, 2015).

Table 4. Revenue-recycling Schemes

3. CLIMATE POLICYMAKING IN ROMANIA AND BULGARIA

3.1. Country profile — Romania

There is no carbon tax in Romania outside the EU ETS. This is in line with the country's unambitious climate objectives (Climate Action Network, 2018), which are a consequence of national economic characteristics. Romania remains one of the poorest countries in the EU (Gherasim, 2020; Melenciuc, 2019), with high levels of inequality (Cretu, 2016; Marica, 2018; Oancea et al., 2017), and large economic disparities between internal regions (Brookings, 2018). To understand the social effects of carbon pricing in Romania, it is essential to study its national economic structure, looking to identify the distribution of carbon-intensive goods and services across the population. Given that Eurostat's most recent data are from the year 2010, I will use this year as a reference.

In 2010, Romania was still recovering from the financial crisis of 2008 (Dediu, 2009; Doltu & Duhaneanu, 2012; Duguleană, 2011). This recession led to high unemployment levels, with the number of people living in poverty increasing from previous years (Stoiciu, 2012; Todor, 2014, 2015). It is worth noting that Romania had been an EU member state only since 2007, meaning that many of the long-term reforms associated with EU membership had not been finalized. In terms of climate policy, efforts were largely concentrated on LULUCF (Irimie, 2010), with no talks about taxing carbon.

While the lack of climate policy in Romania at the time hinders a comprehensive analysis, several points remain significant:

- In rural areas, there is a dependency on livestock for caloric intake. People living outside main cities are practicing subsistence agriculture to meet their household needs. Subsistence agriculture has proven to be one of the most carbon-intensive activities in EE (Czyżewski & Kryszak, 2018).

- Biomass and other biofuels have been used for heating purposes, especially in areas with no access to natural gas. It is important to note that the production and consumption of biomass in Romania has not been sustainable (Aceleanu et al., 2018).
- The lack of policies supporting energy efficiency in buildings resulted in residential facilities with no thermal insulation (Baran et al., 2016; Muresan & Attia, 2017). This is especially relevant in poorer regions of Romania, where dwellings are made primarily from adobe (Hegyi et al., 2016; Jentsch & Beierkuhnlein, 2008).

As a consequence, one should expect the relationship between income and carbon emissions to be monotonically decreasing: the poorer the income groups, the higher level of carbon emissions should be associated with that group. This is confirmed by the available data, represented in Figure 4:

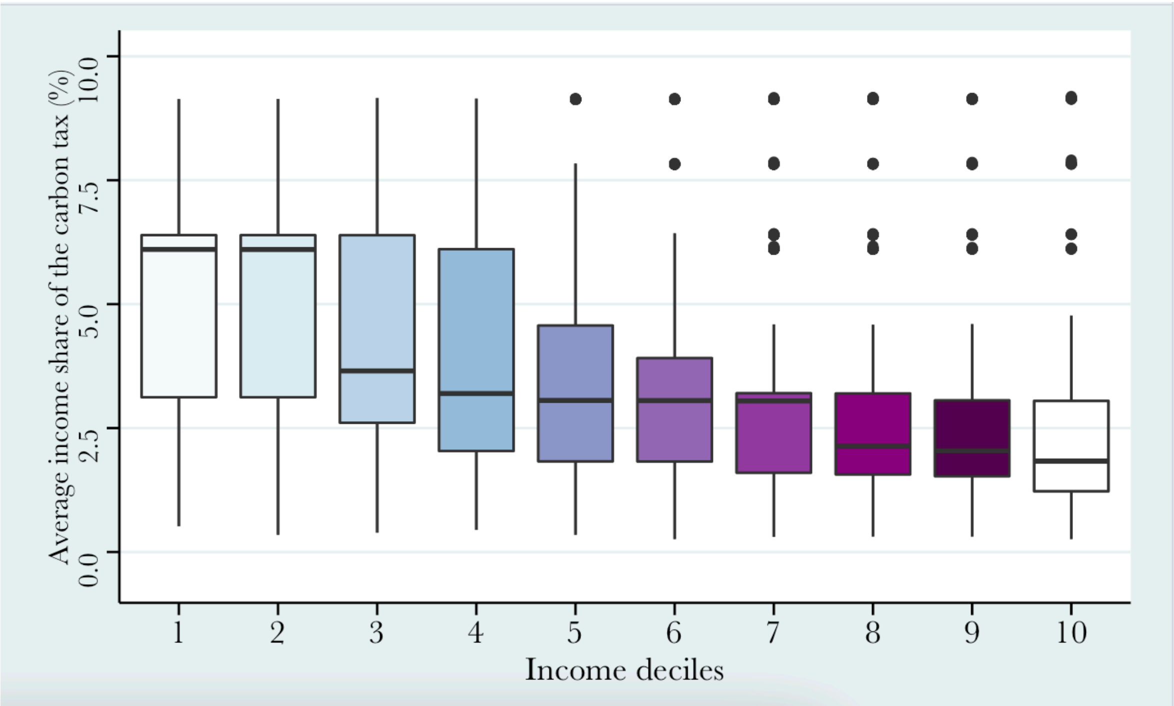

Figure 4. Emissions level across income deciles in Romania

One caveat is that results for more recent years are likely to be different. The economic growth in Romania allowed the development of a carbon-intensive class of rich people that resembles Western states. However, this section of the society was practically non-existent in 2010.

3.2. Country profile — Bulgaria

There is no carbon tax in Bulgaria outside the EU ETS. As in Romania, this is a consequence of the lack of national climate ambitions. In the decades after the fall of communism, Bulgaria's economic structure has been similar with that of Romania, with Bulgaria being marginally poorer (Bogdanov & Tsanov, 2004), and less unequal (Mintchev et al., 2010). The same characteristics that have been identified for Romania are relevant for Bulgaria, with the addition that carbon taxation has been a much more discussed and criticized policy option in the case of the latter. In Bulgaria, carbon taxation has been perceived by the population only as bringing increases in the price of energy. The political climate is opposed to carbon taxation, with previous attempts even leading to Prime Minister Boyko Borisov's resignation in 2013 (Duwe et al., 2014). Available data displays a similar pattern for Bulgaria, as seen in Figure 5:

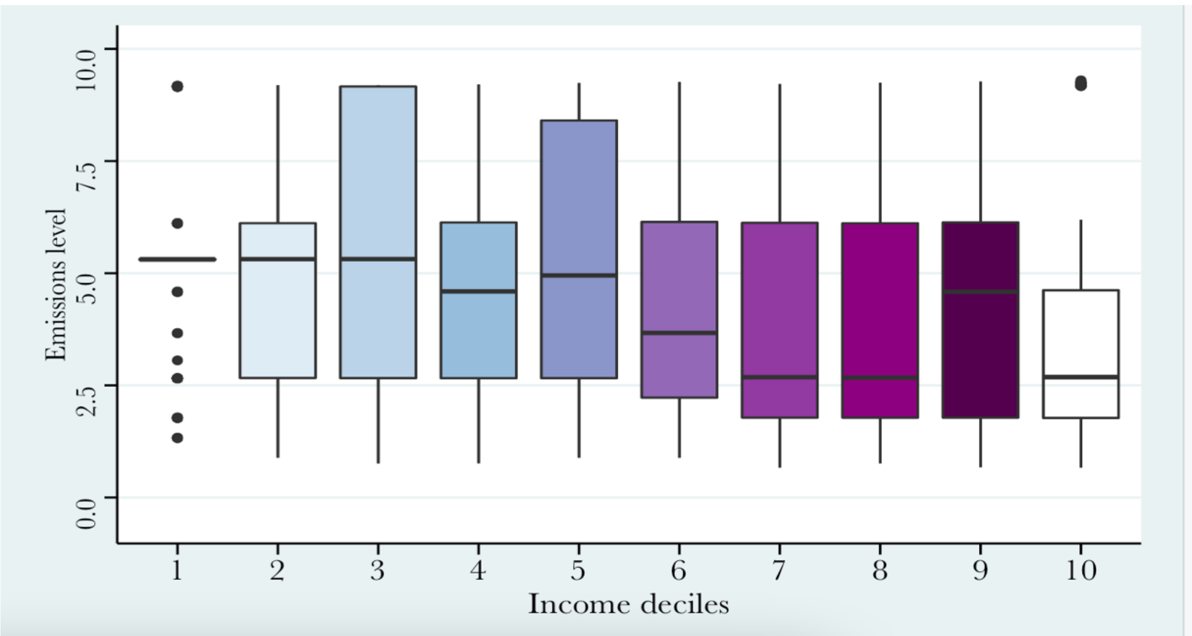

Figure 5. Emissions level across income deciles in Romania[2]

[2] The shape of the boxplot for income decile 1 is due to the poor data quality existing for Bulgaria.

3.3. Rawlsian redistribution in Romania and Bulgaria

3.3.1. Conceptual framework

Climate policy is a policy sector where uncertainty remains a notable obstacle. Although the primary sources of uncertainty are political incoherence (Lockwood, 2013; Mickwitz et al., 2009), coupled with the computational incapacity of anticipating the impacts of climate change (Schlosser et al., 2013; Sokolov et al., 2009; Webster et al., 2012), the lack of access to quality data remains a challenge in many regions. One of these regions is EE. Budgetary constraints, as well as the lack of popular support for climate policy, have hindered quality data collection on energy consumption or carbon footprints.

In this thesis, I propose designing a climate policymaking framework that incorporates uncertainty, using Rawlsian principles of equity (Mandle, 2009; Rawls, 2009). Designing a Rawlsian policy process means assuring that individuals with comparable skills face similar chances of benefiting from the new policy, and that inequalities caused by the new policy work to benefit the least advantaged in the society. When applying this Rawlsian framework to the distributional effects of carbon pricing in Eastern Europe, I infer that for carbon pricing to be fair, revenue-recycling should be designed to avoid regressive effects for the least well-off in society.

To apply this framework, one must be aware that safeguarding the least well-off, while accounting for data uncertainty, will likely increase aggregate welfare losses. While the equity-efficiency trade-off will exist regardless of the revenue-recycling scheme chosen, this Rawlsian framework offers normative support for the political choice. The political dimension of this framework is further analyzed in Chapter 6.

3.3.2. Administrative implications

One consideration has to be the administrative capacity of Romania and Bulgaria to implement this Rawlsian-inspired revenue-recycling scheme. Normative transfers should be designed in a manner that allows the rapid identification of the least well-off, as well as the expeditious calculation by the national bureaucracy of the sums of money owed to each one of the households identified as being vulnerable. What this means is that in countries lacking an effective administration, the dimensions of inequality on which the Rawlsian transfer is computed would have to be determined using a small number of variables.

Currently, indicators such as GINI are widely used by Romanian and Bulgarian bureaucracies, denoting this level of complexity to be acceptable. In Chapter 4, I propose an arithmetic indicator for regressivity, even simpler than the GINI indicator, which could, therefore, be used to determine the beneficiaries of the Rawlsian transfer. This indicator only uses national consumption data to generate information regarding the regressivity level. This implies that the Romanian and Bulgarian authorities have access to data needed to compute the value of this indicator, and, therefore, to determine the beneficiaries of the Rawlsian transfer. Administrative simplicity is one of the political advantages of this indicator, as explained in Chapter 6.

In terms of determining the value of the transfers, there are two options:

- The first would be using a lump-sum transfer, limited to those deemed eligible after the computation of the regressivity indicator.
- The second would be to make the transfer inversely-proportional to the regressivity indicator—in this sense, if you are eligible for the Rawlsian transfer, the worst you are affected by the carbon tax, the higher the transfer.

For the purpose of this thesis, I chose to only discuss the first option, as it would be much more politically feasible. The second option would be indeed more tailored to the needs of heterogenous households, but it would be more complicated to obtain political support for this measure, given the sensitivities existing in Romania and Bulgaria regarding expansive welfare measures.

4. METHODOLOGY

4.1. Datasets

To assess the distributional effects of carbon pricing in Romania and Bulgaria, I combine household consumption expenditure data from the 2010 HBSs with carbon footprint data from an environmental extended multiregional input-output model designed by Ivanova et al. (2017), based on data available from EXIOBASE 2.3.

4.1.1. Consumption data

The HBSs are national surveys focusing on consumption expenditure. They provide information on regionally disaggregated demand patterns from expenditure surveys, following the COICOP classification. The spatial coverage of the HBSs is based on the NUTS taxonomy. The expenditure data are aggregated in 206 consumption sectors, ranging from bread or rice consumption to medical services. A recent version of the HBSs has yet to become accessible, and in the case of EE, the most up-to-date surveys only date back to 2010. In Romania's case, the sample contains 31,336 observations. I have divided the sample into deciles based on net income. A series of descriptive statistics can be found in Figure 6:

Income decile	**Annual income interval (EUR)**	**Average household size**	**Average income per capita (EUR/cap)**
1	0-2384	1.386	1344
2	2384-3079	1.576	1741
3	3079-3734	1.803	1893
4	3734-4384	1.994	2036
5	4384-5093	2.208	2145
6	5093-5877	2.398	2283
7	5877-6842	2.551	2485
8	6842-8113	2.804	2653
9	8133-10238	3.037	2983
10	>10238	3.373	4072

Figure 6. Descriptive statistics for Romania

For Bulgaria, the same classification rules apply to a sample of 2982 households. A similar procedure of constructing income deciles has been used, results of which can be found in Figure 7:

Income decile	Annual income interval (EUR)	Average household size	Average income per capita (EUR/cap)
1	0-1941	1.395	1104
2	1941-2554	1.635	1376
3	2554-3114	1.889	1504
4	3114-3735	2.181	1566
5	3735-4365	2.349	1727
6	4365-5076	2.554	1844
7	5076-5874	2.822	1933
8	5874-7079	2.923	2204
9	7079-8679	3.208	2443
10	>8679	3.671	3106

Figure 7. Descriptive statistics for Bulgaria

4.1.2. Carbon footprints data

The EXIOBASE is a global collection of Multi-Regional Environmentally Extended Supply-Use Tables (MR-SUT) and Input-Output Tables. These MR-IOTs are used to analyze the environmental impact of consumption patterns across industries, both at the national and international levels.

Given these datasets, I have identified a lack of granularity: there is no national methodology of computing the carbon footprint of households by income decile in either Romania or Bulgaria, and the literature on the subject is sparse. Papers investigating carbon emissions in European countries also make use of incomplete datasets, relying , thus, on complex imputations that approximate real CO_2 emission patterns (Godar et al., 2015; Minx et al., 2009; Sommer & Kratena, 2017). Given these gaps in the literature, I propose a new method of imputing household carbon footprint, based on analysis that has been conducted for EE (Ivanova et al., 2017).

4.2. Carbon footprints imputation

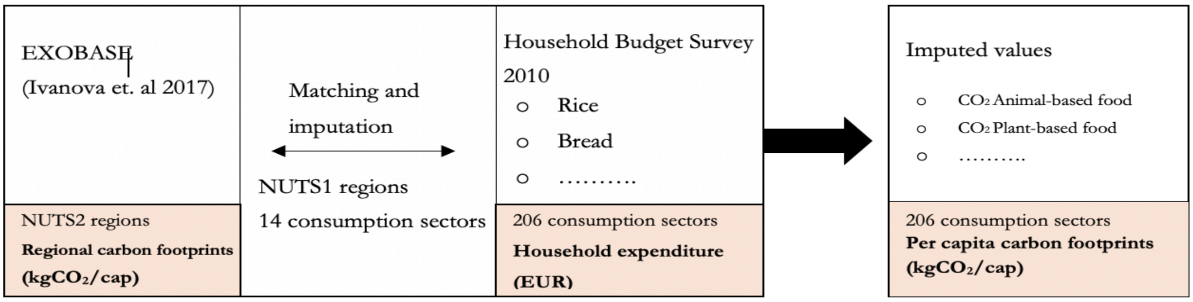

Figure 8. Imputation strategy

Figure 8 offers a visual summary of the imputation strategy developed for this thesis, with the detailed explanations following:

1. The first step in the process is computing average consumption at a regional level for Romania and Bulgaria. For this step, I follow the NUTS1 classification used in the HBSs. This generates six different regional averages: four for Romania, and two for Bulgaria. These six regional averages describe the mean consumption patterns for each economic sector, following the COICOP classification. Given that the HBSs contain information regarding household size, I then compute average regional consumption per capita. Therefore, I obtain information on average per capita consumption for each sector in the economy in each region of Romania and Bulgaria.

2. The second step is the structural harmonization of the HBSs with the EXIOBASE. The EXIOBASE offers, similarly, information on average per capita CO_2 emissions for each sector in the economy, in each region of Romania and Bulgaria. Nevertheless, the regional classification is more granular, using the NUTS2 instead on the NUTS1 classification. In this sense, all NUTS1 regions are composed of two or more NUTS2 regions. Thus, moving towards a NUTS1 distribution in both datasets involves choosing a set of weights for the different NUTS2 sub-regions that constitute a NUTS1 region. For simplicity, I use weights proportional to the share of GDP in each NUTS2 sub-region. This is

an effective choice, as income has been confirmed as a main factor driving population size and CO_2 emissions.

3. The third step involves matching the two datasets. After weighting and homogenizing the regional distribution, the HBSs and the EXIOBASE display the same data structure, allowing to perform an exact matching between the average regional consumption and regional CO_2 footprint. Thus, for each NUTS1 region in Romania and Bulgaria, I have both per capita consumption patterns and carbon footprints in each COICOP sector. This captures size of the relationship between consumption and CO_2 emissions for all the economic sectors in Romania and Bulgaria:

$$e_{ij,} = \alpha + \beta * c_{ij,}$$

Equation 1. Relationship between consumption and emissions

where c_i represents average per capita consumption for COICOP sector *i* and NUTS1 region *j*, and e_{ij} represents average per capita CO_2 emissions in COICOP sector *i* and NUTS1 region *j*.

4. The fourth step involves scaling the HBSs, accounting for the NUTS1 regional distribution, thus moving from per capita consumption of each observation to each observation's deviations from the average regional consumption. After this step, I obtain a dataset containing the original observations in the HBSs, but instead of consumption being measured in EUR, it is now unitless, with each value representing a z-score.

5. The fifth step is re-scaling the z-score table obtained in Step 4I perform the re-scaling using the average carbon footprint values instead of the average consumption values. This is possible because we have performed an exact matching in Step 2. After re-scaling, I obtain imputed per capita carbon footprint data, following the NUTS1 regional distribution and the COICOP

sectoral distribution. This imputation procedure generates estimates of the CO_2 emissions for each household in the original HBSs, measured in tCO_2/cap[3].

A simple robustness check for this imputation method would be to compare total CO_2 emissions in the Romanian and Bulgarian economies to the actual emissions in the year 2010, and the average emissions per capita. For both countries, total emissions and the average emissions per capita are over-estimated by a factor of 1.105, and 1.175, respectively. This shows that the distribution obtained through imputation is the same as the original distribution, only marginally inflated. This can be solved easily through a normalization procedure[4].

This imputation procedure is based on three assumptions:

1. No price variations between NUTS1 regions. This holds for Romania and Bulgaria in 2010, given protectionist measures in the internal energy market. Additionally, outside the energy sector, legal requirements prevent sellers from discriminating based on location, which further proves the validity of the assumption. It will be interesting to see how robust these imputed values are for more recent data, such as the upcoming HBS for 2015, when the liberalization of the energy markets has significantly advanced.
2. Constant energy prices between income deciles. This is a reasonable assumption given the incomplete market liberalization in both countries in. 2010, especially in sectors such as electricity generation or heating

[3] The last two steps could be replaced by running a linear regression, predicting each household's CO2 emissions level in the HBSs based on the coefficient determined at Step 3 Both approaches lead to the same predicted values, as they are parallel imputation methods representing the same causal mechanism.

[4] The issue of different distributions having the same average is still possible, however solving this is beyond the scope of this thesis. For further research, one method of reducing uncertainty regarding the shape of the distribution would be to use either a logistic regression or a random forest to estimate the probability of the averages coming from the original distribution.

3. The HBSs and the EXIOBASE have the same distribution. Given that the EXIOBASE is constructed using consumption data from the HBSs, it is fair to assume that the distribution of the EXIOBASE is either the same the distribution of the HBSs, or a linear transformation of it.

4.3. Descriptive statistics

Figure 9 shows there is an inverse relationship between per capita income and the level of CO_2 emissions in Romania:

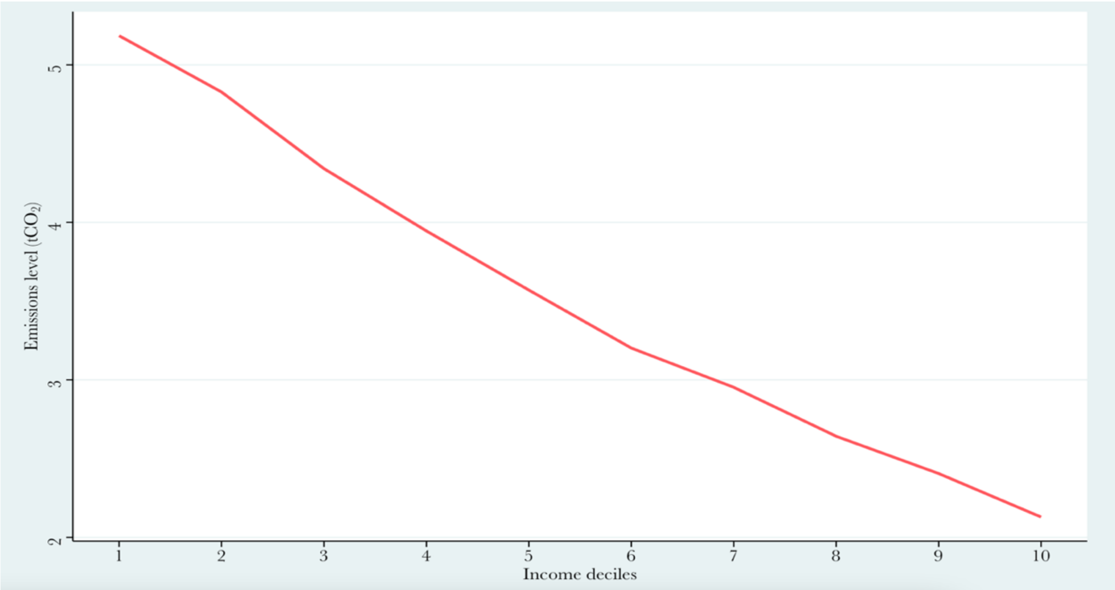

Figure 9. Relationship between income and GHGs emissions in Romania

While these results are surprising for a developed, EU member state, the reasons for this situation in Romania and were explained in Chapter 3. One can predict that introducing a carbon tax would have a strong regressive effect in Romania. Some obvious facts explain the distribution of income across emissions deciles: the lack of access in the rural area to the natural gas system, a very old vehicle fleet used by poorer people, energy-inefficient buildings and appliances, etc.

The same situation applies to Bulgaria, as shown in Figure 10:

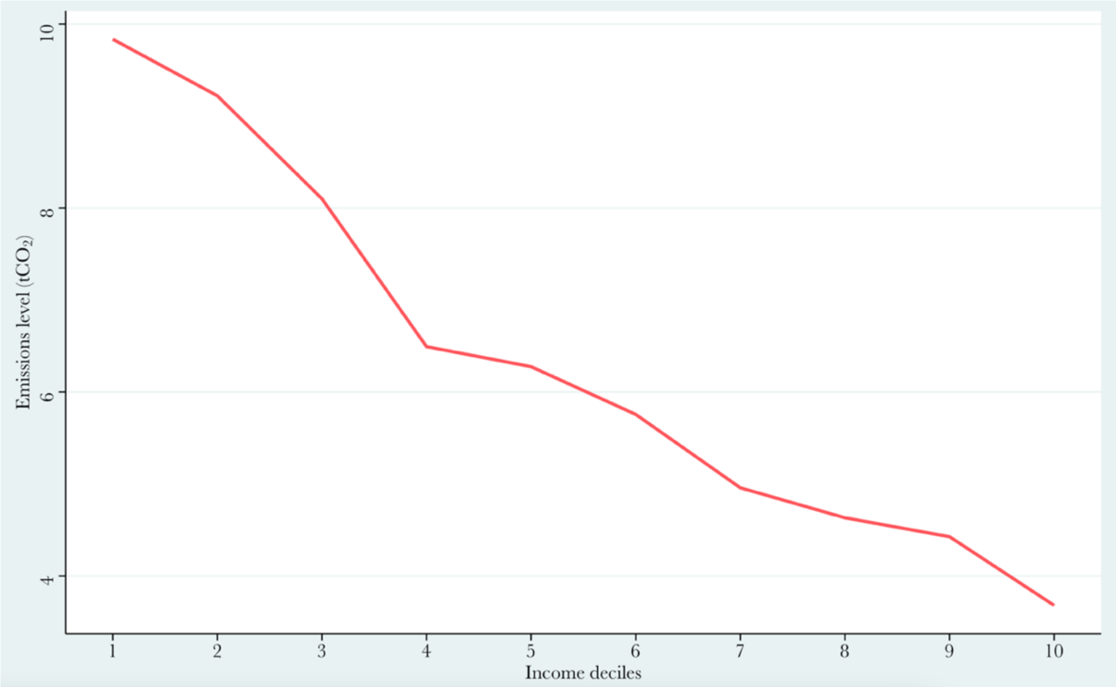

Figure 10. Relationship between income and GHGs emissions in Bulgaria

4.4. Microsimulations

4.4.1. Carbon tax design

I assess the financial costs incurred by households to maintain their original consumption pattern after introducing a general carbon tax. For simplicity, I assume the carbon tax applies uniformly across economic sectors. While this approach disregards disparities between the treatment of EU products and other imports, as well as subsidies for domestic industries, it is a standard approach in the literature (Dorband et al., 2019; Jakob et al., 2014). Following Dorband et al. (2019), I conceptualize this tax as a global, uniform carbon tax or an EU-wide carbon tax with a CBAM for imports from outside the EU. The analysis can also be interpreted as to explain the dynamics of the EU ETS in Romania and Bulgaria, during the previous decade.

4.4.2. Level of taxation

There is no expectation from Romania or Bulgaria to introduce a national carbon tax. Therefore, any choice of the tax level is detached from the authorities' thinking: as such, I propose two scenarios: an entry-level carbon tax of EUR 12/tCO_2, and a very ambitious tax of EUR 34/tCO_2. These choices are based on the average prices of the EU ETS allowances in the years 2010 and 2020.

4.4.3. Design of microsimulations

I employ static microsimulations of household short-term responses. This assumes that households maintain fixed consumption patterns and firms stick to the initial prices. The model describes a scenario in which supply and demand are fully inelastic, which is appropriate for Romania and Bulgaria for the year 2010, given their regulated economies. Nevertheless, one must be aware that using a static model has the potential to overstate vertical distributional effects (Araar et al., 2011; Davis & Knittel, 2019; Ohlendorf et al., 2018).

However, given that eventual demand responses are likely to be heterogeneously distributed across unobserved socioeconomic characteristics, simulating a demand system might lead to very model-sensitive results. This weakness of demand estimation is proven by the significant differences found between the sizes of the effects found in the current literature (Frondel et al., 2019; Tovar Reaños & Wölfing, 2018). This observation, as well as the lack of quality time-series data, justifies choosing a static approach in this thesis.

I compute the annual additional tax burden from the carbon tax for household *i* after the introduction of the carbon tax *t* as a multiplicative function of the carbon footprints of consumption *c* in each sector *j* (tCO_2) and the tax rate imposed by the government (EUR/tCO_2)[5]:

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[5] The assumption behind this function is that the carbon tax applies uniformly for each consumption sector. If the tax would be differentiated between sectors based on the average carbon intensity of the sector (e.g., a higher tax for fuels than for animal products), we could derive carbon intensities from the Global Trade Analysis Project, following recent developments in the field (Todor, 2015). In that case, the annual additional burden from the carbon tax would depend not on the sectoral carbon footprint, but rather on the product between the carbon intensity *k* of sector *j* and the total expenditure α of household *i* in the sector *j*, and the tax rate for sector *j*.

$$burden_i = \sum_j c_j * t$$

Equation 2. Tax burden formula

After computing additional tax burden for each household, I move towards computing, for each income decile, the average annual additional tax levy. The first step is calculating the share of income represented by the tax levy for each income decile. To check this measure's robustness, we calculate the tax levy relative to the national average for each income decile. This approach, designed and used by Dorband et al. (2019), has the advantage of not being model-sensitive, which is crucial given the limitations of the available data. The rationale behind this approach is that if a household consumes a large share of goods and services from carbon intensive sectors, they will disproportionately bear the costs of the newly-imposed carbon tax.

Assuming that an income group *i* deviates from the average consumption in sector *j* by $\Delta c = c_{ij} - c_j^{avg}$, we can express the distributional effects of the carbon tax on the income group as following:

$$\delta = \frac{\sum_j c_{ij}}{\sum_j c^{avg}} = \frac{\sum_j (\Delta c + c_j^{avg})}{\sum_j c^{avg}} = 1 + \frac{\sum_j \Delta c}{\sum_j c^{avg}}$$

Equation 3. Regressivity indicator

Suppose households from a given income group consume more from a sector than the average national consumption in that sector, $\delta > 1$. If their consumption level is below the national average, $\delta < 1$. This measure will be central for implementing the Rawlsian revenue-recycling scheme described in Chapter 3.

$$burden_i = \sum_j k_j * \alpha_{ij} * t_j$$

4.4.4. Equity measurement

I avoid estimating utility functions, necessary for the classic equity measurements used by Slesnick (1989), or for similar variations as in Rausch et al. (2011), Rausch and Schwarz (2016), as these would involve the estimation of demand systems for Romania and Bulgaria, which is beyond the scope of this thesis. As such, I propose the share of households facing losses (Berry, 2019) as well as an updated version of the δ indicator described in the previous sub-section for measuring different revenue-recycling schemes.

The first measure would offer information on the share of population affected, while the second measure captures the magnitude of the effect of the revenue-recycling schemes. When jointly analyzed, these measures offer a comprehensive picture on how revenue-recycling alleviates the regressivity of carbon pricing in EE.

4.5. Interviews

The second part of the methodological setup is represented by a series of qualitative semi-structured interviews (Carruthers, 1990; Drever, 1995; Newcomer et al., 2015). A common set of questions was prepared in advance, while context-specific questions were included during the discussion based on the characteristics of each interview. The list of interview partners was built based on detailed research of existing academic literature, professional social media platforms such as LinkedIn, as well as through a pre-interview discussion with representatives of two large think tanks in Romania and Bulgaria: Energy Policy Group and Center for the Study of Democracy, respectively. Given the COVID-19 public health crisis, all the interviews were conducted online, using the CISCO Webex platform, also used for transcribing interviews for further research. Interview partners were informed that any information that can be linked to their identity will be anonymised, with the exception of the relevant sectors in which they are working or had been working for in the past. The majority of the interviews were conducted in English, with the exception of one which was conducted in Romanian, with the average duration of an interview of around 35 minutes.

To generate a clear picture of the energy sector in Romania and Bulgaria, and of the socio-political dimension of climate policy in Eastern Europe, I have gathered data from across a broad sample of stakeholders (McIntosh & Morse, 2015). As a consequence, partners come from three main sectors: business, society and the political environment (Table 5).

SECTOR	TYPE OF ACTOR	COUNTRY	DATE OF INTERVIEW
Business	Carbon trading consulting firm	Romania	24.02.2021
Business	Heat industry private firm	Bulgaria	10.03.2021
Society	Think tank	Bulgaria	04.02.2021
Society	Think tank	Romania	04.02.2021
Political	European Parliament	Romania	25.02.2021
Academia	University	Romania	13.03.2021
Academia	University	Romania	10.03.2021
Society	Think tank	Bulgaria	13.03.2021
Business	Consulting firm	Romania	02.03.2021
Business	Electricity industry private firm	Romania	21.01.2021

Table 5. List of interview partners

5. ANALYSIS

5.1. Distributional effects of carbon pricing in Romania

5.1.1. Vertical distributional effects

Figure 11 displays the vertical distributional effects of carbon pricing in Romania by plotting the incidence of both a EUR 12/tCO_2, and a EUR 34/tCO_2 tax across income deciles.

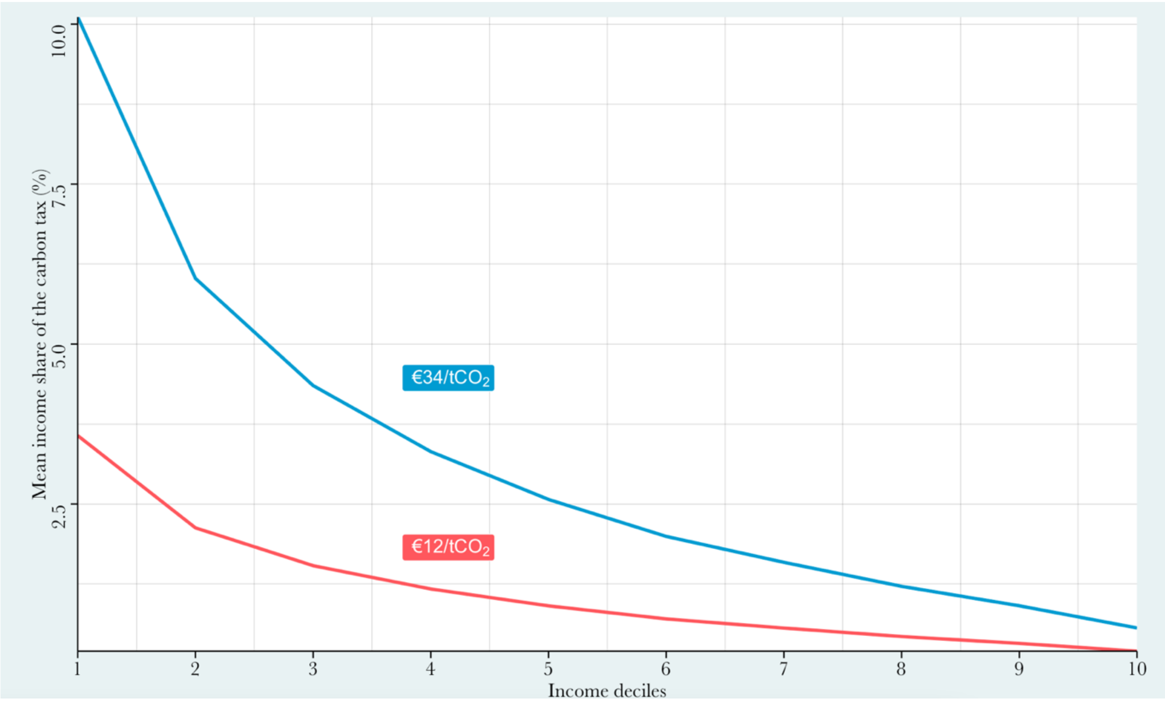

Figure 11. Vertical distributional effects of carbon pricing in Romania

When expressed as a percentage of annual consumption expenditure per household, carbon taxation is vertically regressive in Romania. The direct implication of Figure 11 is that carbon pricing in Romania would disproportionately affect households from the lower income-deciles, thus inducing a much higher policy effort for the least well -off in society. In the case of the EUR 34/tCO_2 tax, the results are extreme, as the price of carbon would represent more than 10% of annual consumption expenditure for the lowest income-decile, and only 0.56% of annual consumption expenditure for the richest 10% of the population. This harsh tax incidence can be explained by Romania's high poverty level in 2010, when the minimum wage was only EUR 142/month and the median wage was barely EUR 385/month. Corroborated with the carbon-intensive lifestyle displayed by poor people in EE, the expectation would indeed be that carbon taxation would severely punish the least well-off. While the EUR 12 /tCO_2 produces the same vertical distributional effect, the steepness of the tax curve is less pronounced. This suggests that by choosing the EUR 12/tCO_2 rate, it would be easier to achieve progressivity through revenue-recycling.

To characterize the regressivity of carbon taxation, I also look at the regressivity indicator described in Chapter 4, δ. Figure 12 displays this scenario and confirms the regressivity of carbon taxation in Romania, with large variations in the indicator, as $\delta \in [0.6, 1.47]$. δ becomes sub-unitary from the sixth income decile, suggesting that income is a strong indicator of the burden a carbon tax imposes on the different earning groups. Combined with the linearity of δ, these characteristics suggest that in theory, one could redistribute the revenue resulting from those who pay below average to compensate for the additional costs suffered by the ones who pay above average. While the optimization of the transfer needs to be further addressed, it's important to note that regressivity appears to be a consequence of carbon pricing only before revenue-recycling.

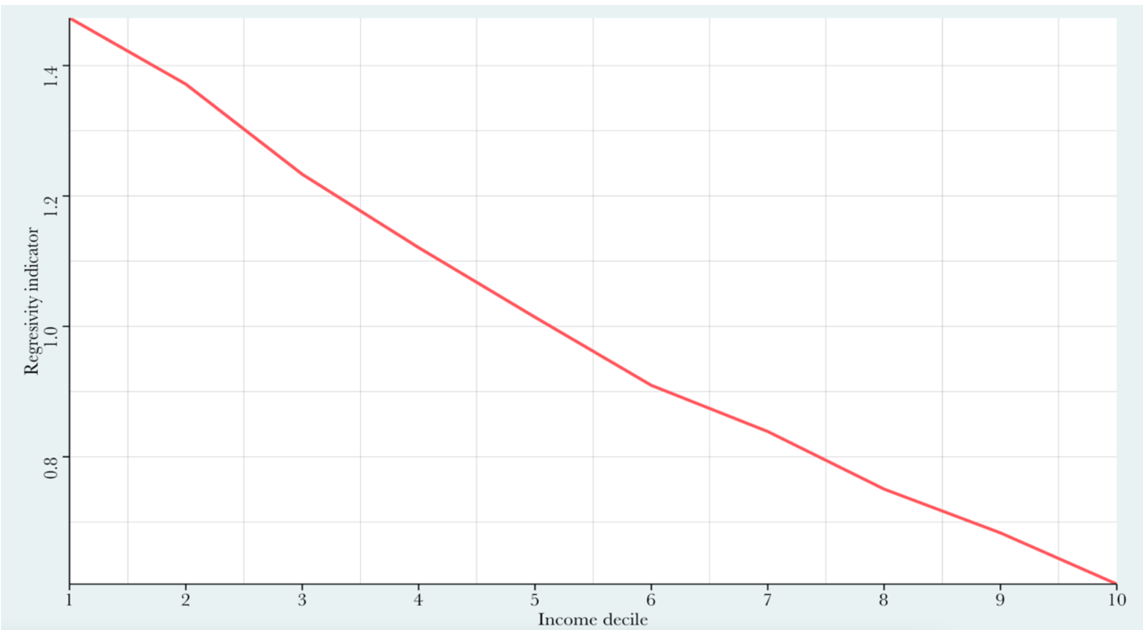

Figure 12. Regressivity of carbon pricing in Romania

The table displayed in Figure 13 offers a better understanding of how households in each income decile are affected by the potential carbon taxes, as well as the mean regressivity indicator δ across income deciles. We can infer that the most affected groups in the society are households from the five lowest income-deciles. The last column shows that regardless of the size of a uniform carbon tax, the poorest 50% of the population would be disproportionately affected due to their carbon-intensive consumption pattern, given that all of these income deciles exhibit an average $\delta > 1$.

Income decile	**Mean income share of EUR 12/tCO$_2$ tax (%)**	**Mean income share of EUR 34/tCO$_2$ tax (%)**	**Average δ per decile**
1	3.569	10.112	1.473
2	2.126	6.026	1.371
3	1.535	4.350	1.233
4	1.171	3.318	1.120
5	0.907	2.570	1.101
6	0.703	1.992	0.909
7	0.560	1.587	0.838
8	0.427	1.212	0.750
9	0.320	0.908	0.683
10	0.198	0.562	0.604

Figure 13. The incidence of carbon pricing across income-deciles in Romania

One surprising result is seeing that even the richest households in Romania would pay on average more than the median household in Western European countries such as Germany or France, as a share of annual consumption expenditure. Once again, this can be explained by Romania's comparative-poverty – in 2010, the median wage in Romania was only EUR 344, almost five times lower than the minimum wage in France in the same year.

A policy implication of this incidence on the wealthier people in Romania is the potential lack of support for introducing any form of carbon taxation. Usually, in developed countries, people from the upper income deciles are more supportive of strong climate action. However, given the impact any particular carbon tax would have on the budget of the wealthier people, their support for carbon pricing in Romania could be drastically reduced, despite the impact of such a tax on the emissions level. One intermediary conclusion is that when looking at EE countries around 2010, one must approach these countries more like their developing neighbors from the former Soviet Union and less like a typical EU member state. Any attempt to conduct climate policy in Romania on the same grounds and using the same policy tools as, for example, in Germany, is likely to face obstacles from all parts of the population.

The carbon footprint of lower income deciles is dominated by carbon-intensive food production, mobility, and dwelling. Figure 14 offers a visualization of the determinants of carbon tax incidence in Romania. We can see that in relative terms, poor people pay more for all spending categories that tend to be carbon-intensive, given the life conditions described in Chapter 3. One striking factor is that households from the poorest income-group tend to pay double that of households from the richest income-group on essential needs. This shows that carbon taxation in Romania could achieve distributional neutrality only through an aggressive redistribution strategy.

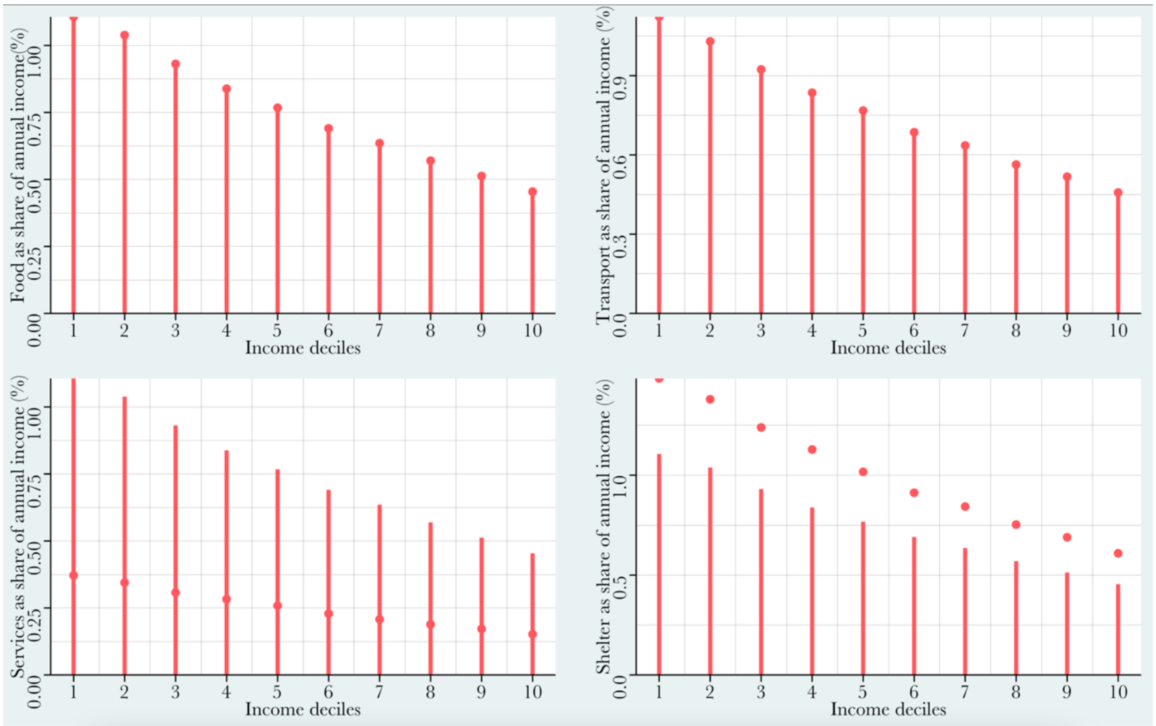

Figure 14. Determinants of the incidence of carbon pricing in Romania

5.1.2. Revenue-recycling options

In order to properly analyze the distributional effects of carbon pricing, we need to account for potential revenue-recycling options. In the case of Romania, the revenue obtained through applying a EUR 12/tCO_2, carbon tax on our sample would be EUR 1.323 billion, while applying a EUR 34/tCO_2, carbon tax would result in a revenue of EUR 3.75 billion. This section analyses two mechanism of spending the revenue to mitigate the regressivity of carbon pricing:

- A lump-sum payment which would result in an equal per-household distribution of the revenue obtained from the imposition of a carbon tax.
- A Rawlsian transfer, in which people shown to disproportionately bear the costs of carbon pricing receive a transfer. In this case, I use the regressivity indicator δ as a measure of policy effort—if $\delta > 1$ for a given household in the sample, that household will be eligible for the transfer.

Figure 15 shows the distributional effects of carbon pricing over income deciles after redistributing revenues through a lump-sum transfer. In the case of the EUR 12/tCO_2, carbon tax, the lump-sum would be EUR 42.24, while in the case of the EUR 34/tCO_2, carbon tax, the lump-sum would be EUR 119.68.

While this revenue-recycling scheme would make both carbon taxes less regressive, only in the case of a carbon price of EUR 12/tCO_2, would the tax be close to neutrality. In the case of the low carbon price, all deciles except the first, have resulting policy effort of just under 1% of annual consumption expenditure. In the case of the high carbon price, however, the first three deciles would still have to pay more than 1% of their annual consumption expenditure, which is a much higher sum than what is expected to be paid for carbon in Western countries. This figure also demonstrates that an EUR 34 /tCO_2 carbon tax would be politically unfeasible, as it would force people living on minimum wage to save two weeks' worth of their income for the purpose of paying the carbon tax.

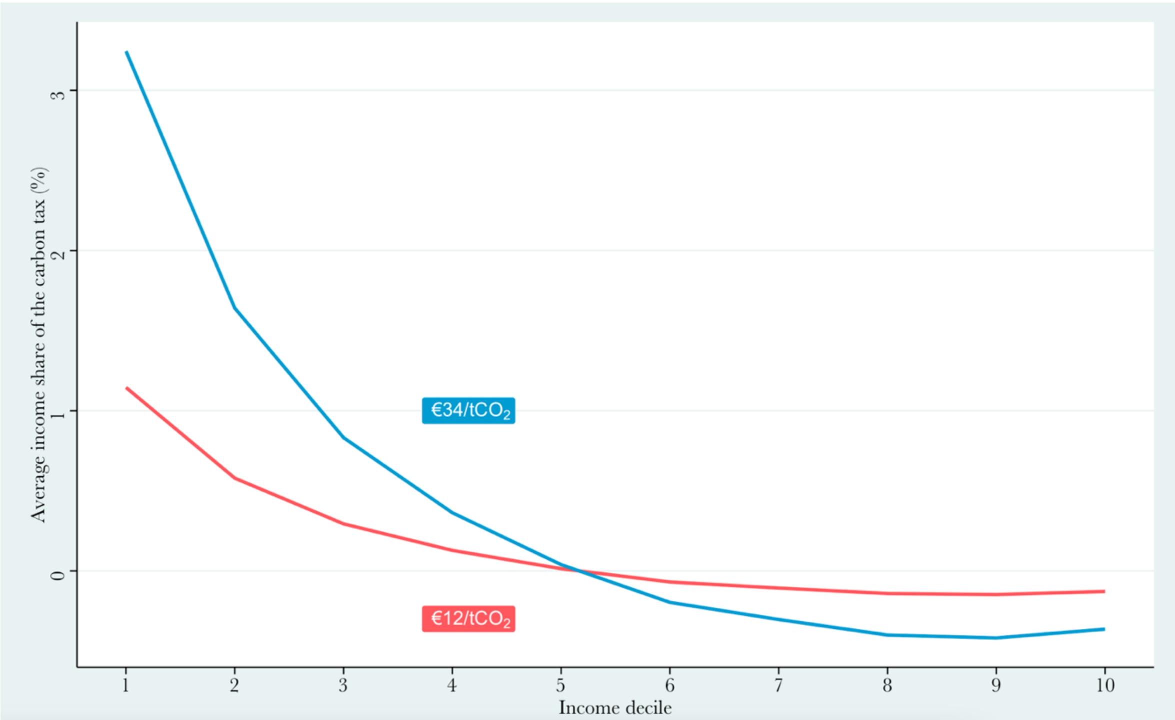

Figure 15. Vertical distributional effects of carbon pricing with lump-sum redistribution

By comparing the two taxes after redistribution, one can observe that richer households would disproportionately benefit from the process of redistribution in the case of the larger carbon price. While this is a consequence of the distribution of carbon-intensive activities across the population in 2010, from a political perspective it is improbable that such a tax would be popular, as it would redistribute money from the poor to the rich. Thus, under the lump-sum redistribution scheme, only a low carbon price would be feasible. Nevertheless, it would still not be progressive. One interesting point is that in Western states, such as Germany or France, lump-sum transfers are sufficient to assure tax neutrality, and sometimes even progressivity. A large part of this difference can be explained by the extreme effects the carbon taxes would have on the lower income-deciles. In turn, these extreme effects are the result of the structure of the Romanian economy in 2010. Additionally, the lack of a carbon-intensive rich class implies that the total sum collected from the carbon tax will not be sufficiently high to compensate the distributional effects for the entire population.

Given that the lump-sum transfer has proven to be sub-optimal in mitigating the vertical distributional effects of a carbon tax, I move towards a normative revenue redistribution system, based on Rawlsian principles. As previously mentioned, I use the regressivity indicator δ as a measure of policy effort. I firstly select only households with $\delta > 1$, which implies that they are overpaying for carbon given the national averages. The redistribution of revenues obtained from a carbon tax is then focused on these individuals. From our sample of 31.336 households in Romania, 11.223 cases with $\delta > 1$ are eligible for Rawlsian transfers. Figure 16 shows the distributional effects of carbon pricing in Romania under Rawlsian redistribution. In this case, carbon pricing would be highly progressive. The only households that would actually incur any costs of carbon pricing would be from the richest 4 income deciles.

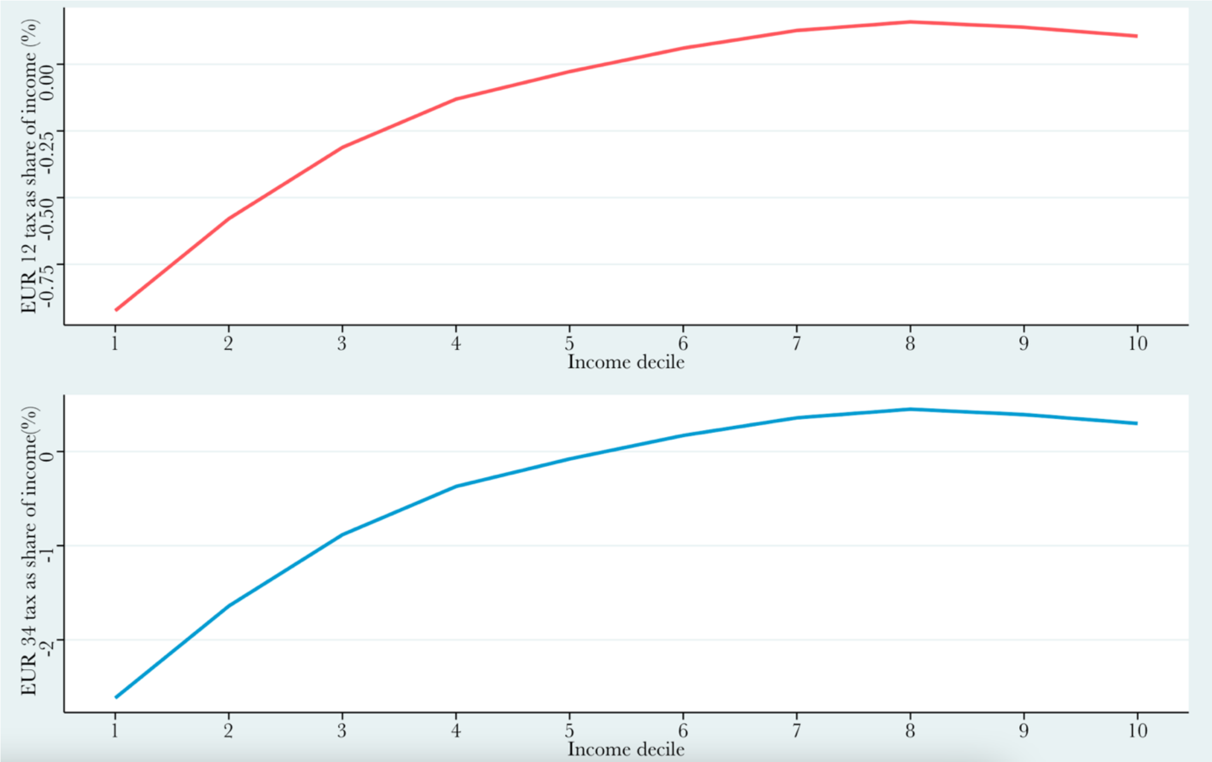

Figure 16. Vertical distributional effects of carbon pricing in Romania with Rawlsian redistribution

Nevertheless, while socially optimal, this might not be optimal from the perspective of internalizing the climate externality—people that are disproportionately responsible for carbon emissions should bear more of the costs of carbon pricing, otherwise the assumptions of this policy are purely theoretical.

From a behavioural perspective, this policy might be more complex than the current thesis discusses. When faced with increased prices at the shelf, people are not acting fully-rational by computing the expectation of receiving transfers and deducing it from the price of the carbon-intensive goods. One would need to compute both the demand and the supply behavioural responses, although this is beyond the scope of the current thesis.

5.1.3. Horizontal distributional effects

If in terms of vertical effects, it is clear that carbon pricing would be regressive in Romania. However, it is also crucial to analyze the horizontal distributional effects. Given the data currently accessible, the only measure for which I can compute horizontal tax incidence is the regional distribution. Additionally, given the extreme results achieved by imposing any carbon tax in the absence of revenue-recycling schemes, this section focuses on the horizontal distributional effects in the presence of a lump-sum redistribution. The Rawlsian-based redistribution strategy is not portrayed, as Romania forbids any form of regional discrepancy in the case of fiscal policy.

Figure 17 displays the incidence of both a EUR 12/tCO_2, and a EUR 34 /tCO_2 across the NUTS1 regions in Romania. The lower tax would imply a policy effort rate between 1.04%-1.31% of annual regional consumption expenditure, while the higher tax implies an effort rate between 2.96%-3.72%. While the inter-regional discrepancies remain rather small, I nevertheless observe a significant gap between two NUTS1 regions in Romania: RO3, where the policy effort rate implied by carbon pricing is the smallest, and RO4, where the effort is the largest.

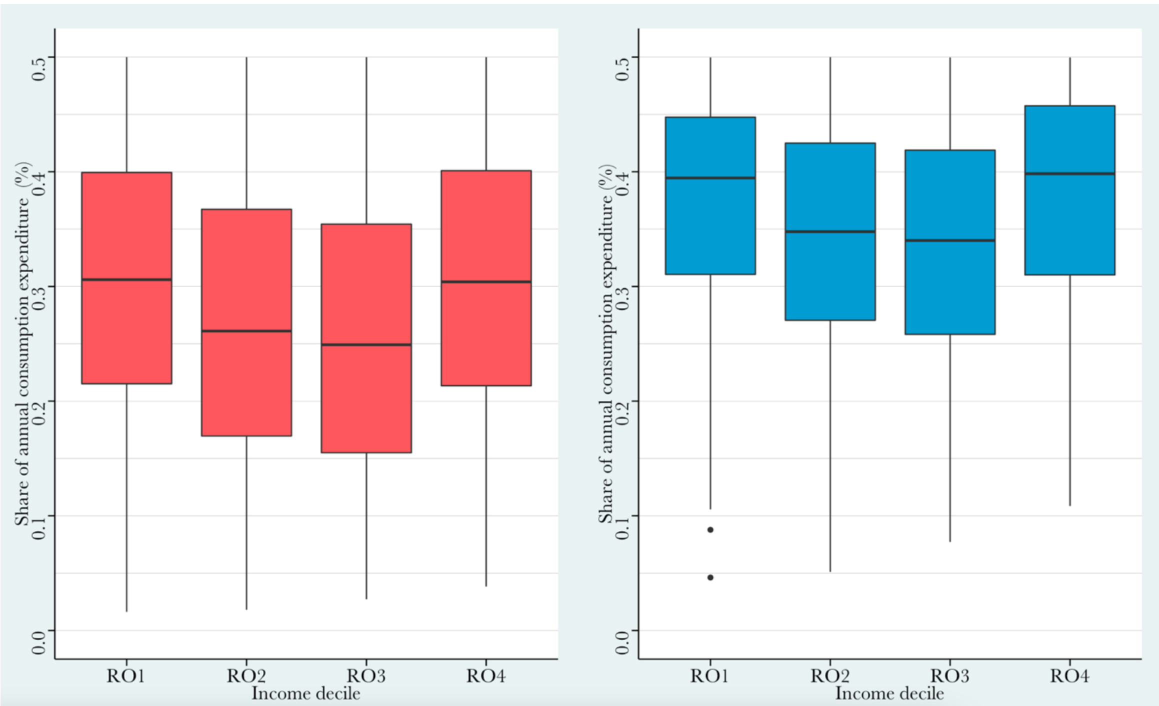

Figure 17. Horizontal distributional effects of carbon pricing in Romania

While the available data do not allow me to fully characterize the determinants of the horizontal distributional effects quantitatively, there are a couple of hypotheses worth discussing in future research:

- RO4 is the primary agricultural region of Romania, as well as the least dense region. Subsistence agriculture has been central to regional development until recent years.
- RO3 is the region containing Bucharest, the most developed part of Romania. As such, it is more likely that this region's economic structure resembles the EU's economic structure and it is less reliant on carbon-intensive activities.

Lastly, Figure 18 shows the combined distributional effects of carbon pricing in Romania, prior to any form of redistribution. As one would expect, while carbon pricing affects the four Romanian regions in a unique manner, it is nevertheless constantly regressive.

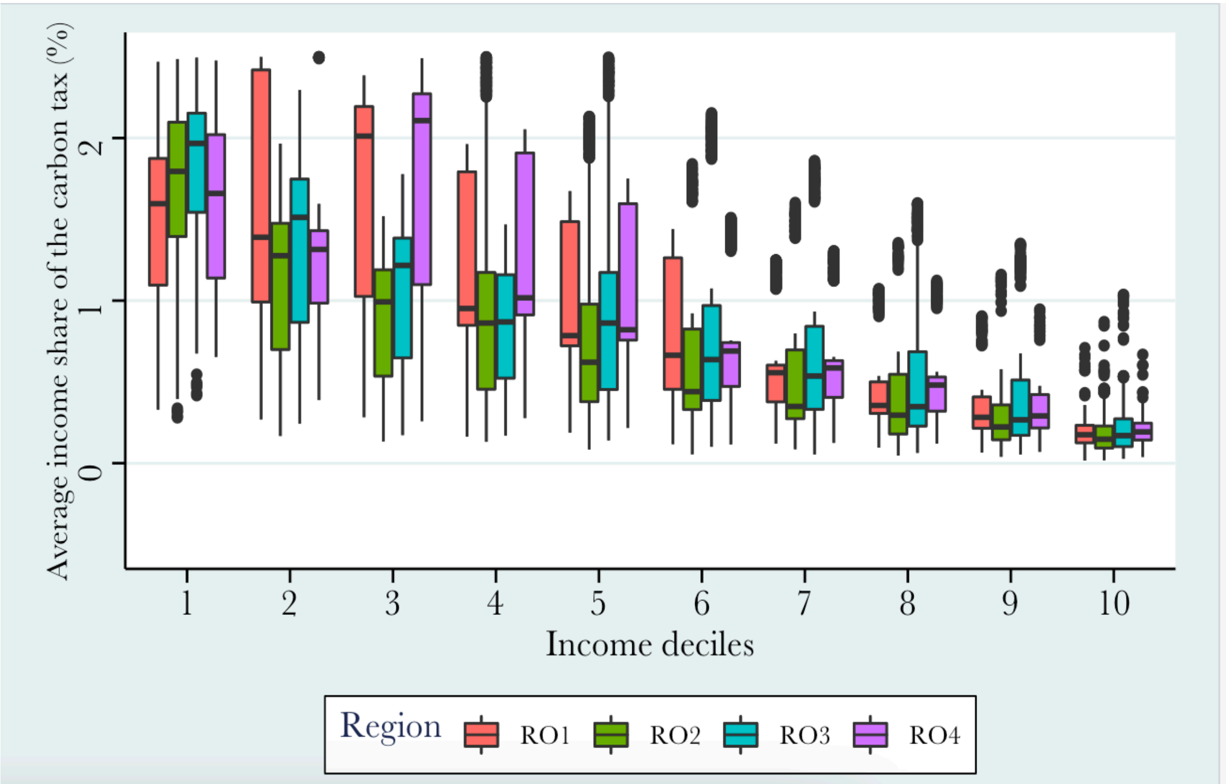

Figure 18. Distributional effects of carbon pricing in Romania

5.2. Distributional effects of carbon pricing in Bulgaria

5.2.1. Vertical distributional effects

Figure 19 shows the incidence of a EUR 12/tCO_2, and a EUR 34/tCO_2 across income-deciles. When expressed as a percentage of annual consumption expenditure, carbon taxation is vertically regressive, like in Romania. In the case of the higher carbon price of EUR 34/tCO_2, the results, similar to the Romania case, are extreme, as the price of carbon would represent more than 20% of annual consumption expenditure for the lowest income decile. The same explanation is valid in the case of Bulgaria—high levels of poverty in 2010, when the minimum wage was only EUR 142/month, as well as carbon-intensive consumption patterns of the least well-off.

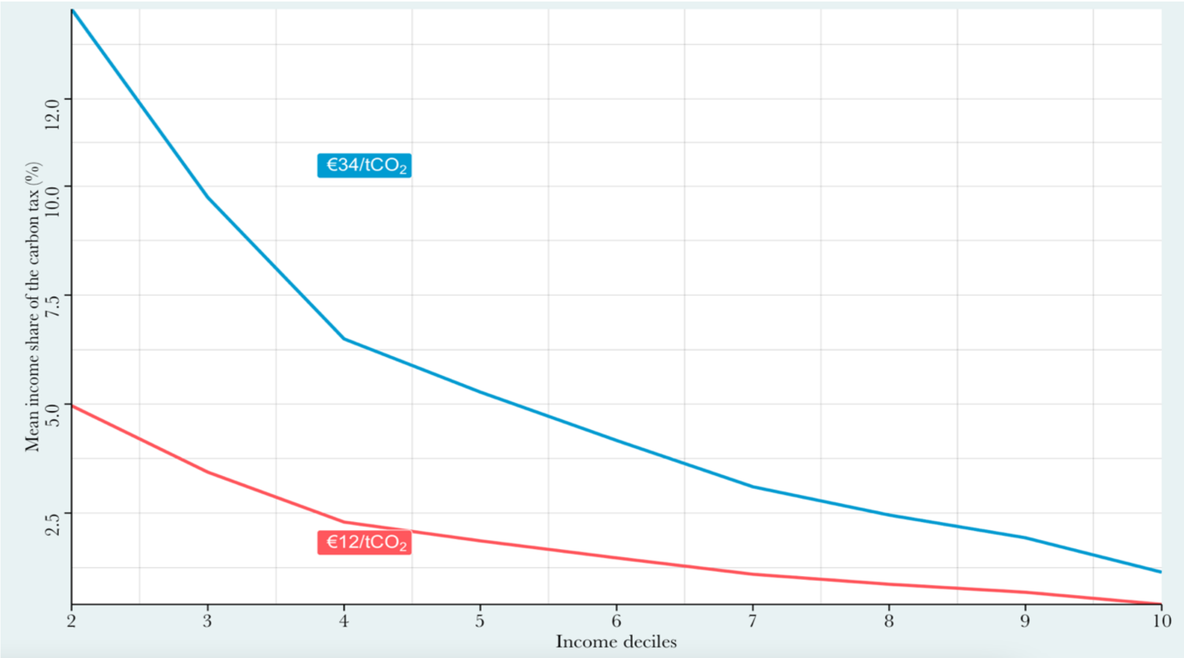

Figure 19. Vertical distributional effects of carbon pricing in Bulgaria

To characterize the regressivity of carbon taxation, we also look at the regressivity indicator, δ. Figure 20 displays this scenario and confirms the regressivity of carbon taxation in Bulgaria, for any levels of taxation. One difference from the Romanian case is that the δ function is nowhere close to being linear, but rather a high-degree polynomial. This suggests, at a first glance, that simple revenue redistribution schemes will be unable to achieve a fair distribution across all income-deciles.

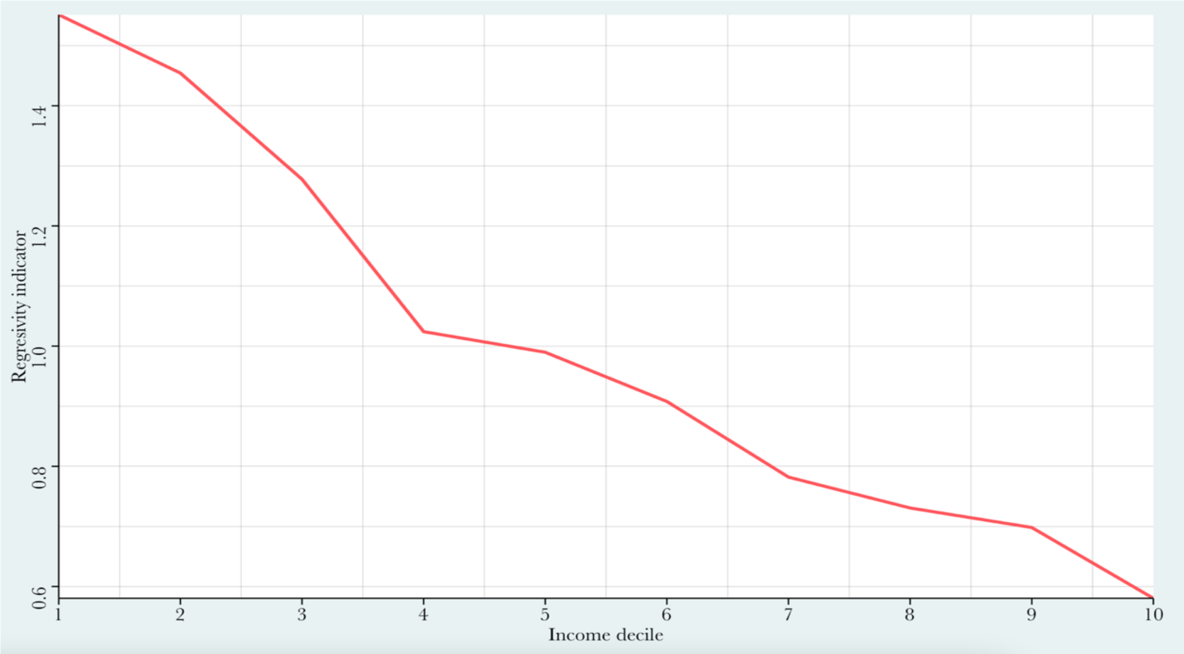

Figure 20. Regressivity of carbon pricing in Bulgaria

The table displayed in Figure 21 displays the average costs of households from each income deciles expressed as a share of annual consumption expenditure, as well as the regressivity indicator δ for each income decile. We observe that $\delta \in [0.58, 1.55]$ and is , therefore, an even larger variance than in Romania.

Income decile	**Mean income share of EUR 12/tCO$_2$ tax (%)**	**Mean income share of EUR 34/tCO$_2$ tax (%)**	**Average δ per decile**
1	8.073	22.873	1.551
2	4.963	14.062	1.454
3	3.437	9.740	1.277
4	2.292	6.494	1.024
5	1.861	5.274	0.989
6	1.469	4.164	0.907
7	1.094	3.102	0.782
8	0.865	2.454	0.730
9	0.681	1.931	0.698
10	0.403	1.142	0.580

Figure 21. Tax incidence of carbon pricing in Bulgaria

I deduce from this table the most affected groups in the society are households from the four lowest income-deciles. Even in the case of the lowest carbon tax, households would have to pay significantly above EU averages. The last column of the table shows that regardless of the size of a uniform carbon tax, the poorest 40% of the population, and especially the poorest 30%, would be disproportionately impacted. Like in the case of Romania, even the richest households in Bulgaria would pay on average more than the median household in Western European countries such as Germany or France, as a share of annual consumption expenditure. The reasons have been discussed in the previous section.

Lastly, we look at Figure 22 to understand the determinants of tax incidence in Bulgaria. The carbon footprint of the lower income-deciles in Bulgaria is dominated by carbon-intensive food production, mobility and dwelling. Like in the Romanian case, these findings are compatible with the expectations laid out in Chapter 3.

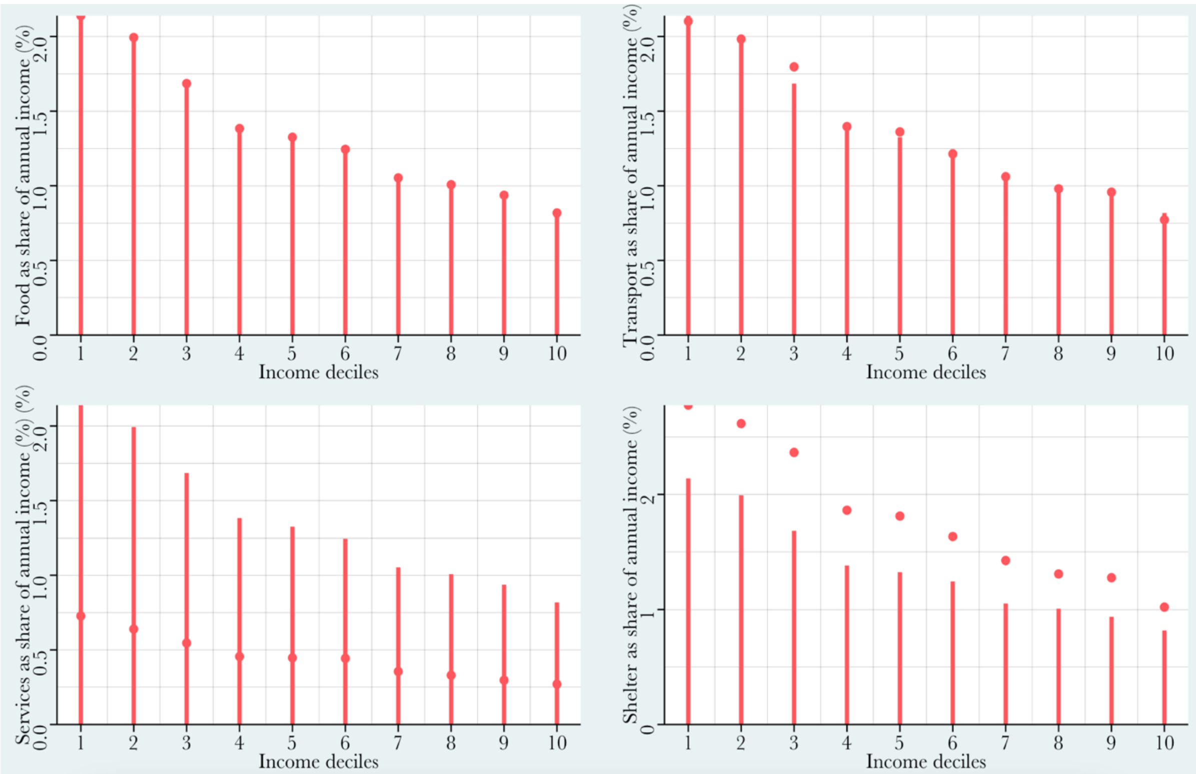

Figure 22. Determinants of carbon pricing in Bulgaria

5.2.2. Revenue-recycling options

In the case of Bulgaria, the revenue obtained through applying a EUR 12/tCO_2, carbon tax on our sample would be EUR 262.82 million, while applying a EUR 34/tCO_2, carbon tax would result in a revenue of EUR 642.80 billion. I analyze the same two mechanisms of spending the revenue as in the previous section, namely the lump-sum transfer and the Rawlsian transfer. The differences between Bulgaria and Romania will be mentioned whenever relevant, to build a comparative understanding of the distributional effects of carbon pricing in the two EE countries.

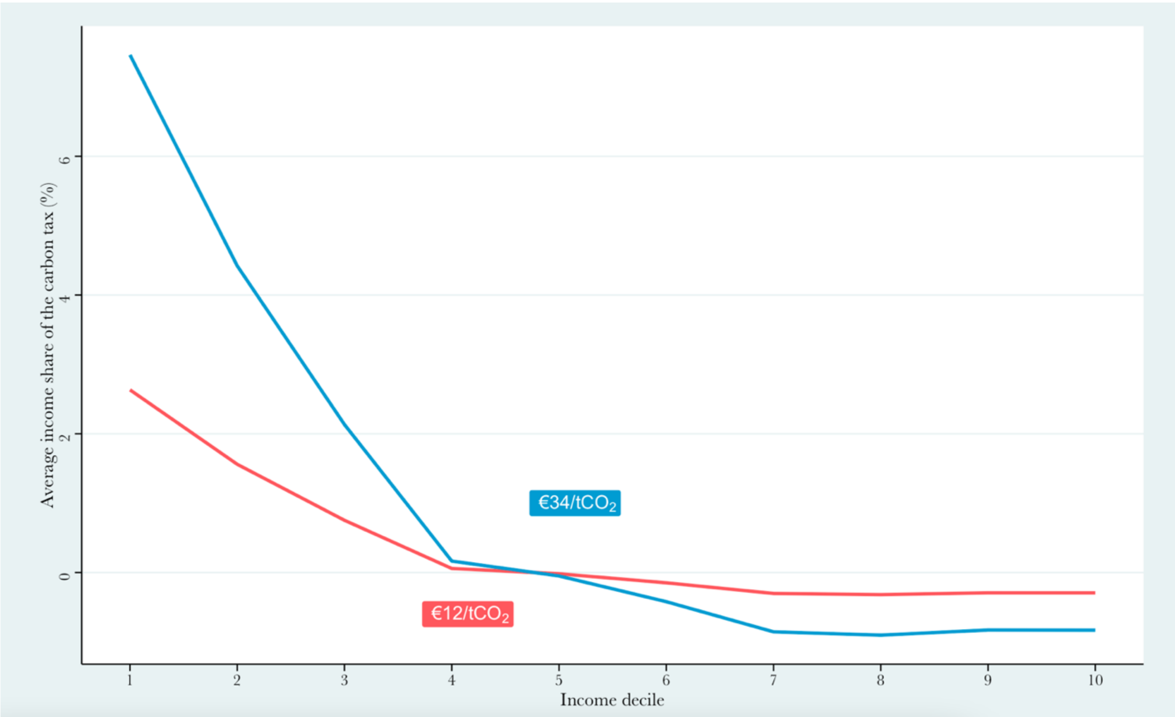

Figure 23. Vertical distributional effects of carbon pricing in Bulgaria with lump-sum redistribution

Figure 23 shows the distributional effects of carbon pricing over income deciles after redistributing revenues through a lump-sum transfer. In the case of the EUR 12/tCO_2, carbon tax, the lump-sum would be EUR 42.24, while in the case of the EUR 34/tCO_2, carbon tax, the lump-sum would be EUR 215.51.

While this revenue-recycling scheme makes both carbon taxes less regressive, only in the case of a carbon price of EUR 12/tCO_2, would the tax be close to neutrality. In the case of the low carbon price, all deciles except the first have resulting policy effort of just under 2.5% of annual consumption expenditure, and only the first income-decile has a policy effort above 1%. In the case of the high carbon price, however, the first three deciles would still have to pay more than 2% of their annual consumption expenditure, which is a much higher sum than what is expected to be paid for carbon in Western countries. Like in the Romanian case, one can observe that in the case of the larger carbon price, richer people would disproportionately benefit from the process of redistribution. The highest four deciles would in fact receive money after the transfers.

From our sample of 2,982 households in Bulgaria, 875 have $\delta > 1$, making them eligible for Rawlsian transfers. Figure 24 displays the incidence of a EUR 12/tCO_2, carbon tax after a Rawlsian revenue-recycling scheme. Even in this case, carbon pricing is not progressive. However, the policy effort for people from the most affected income-deciles would be very small—less than 1% of annual consumption expenditure. Also, the tax would be quasi-progressive if restricted to deciles 3-10, which would imply further special consideration to the poorest 20% in Bulgaria.

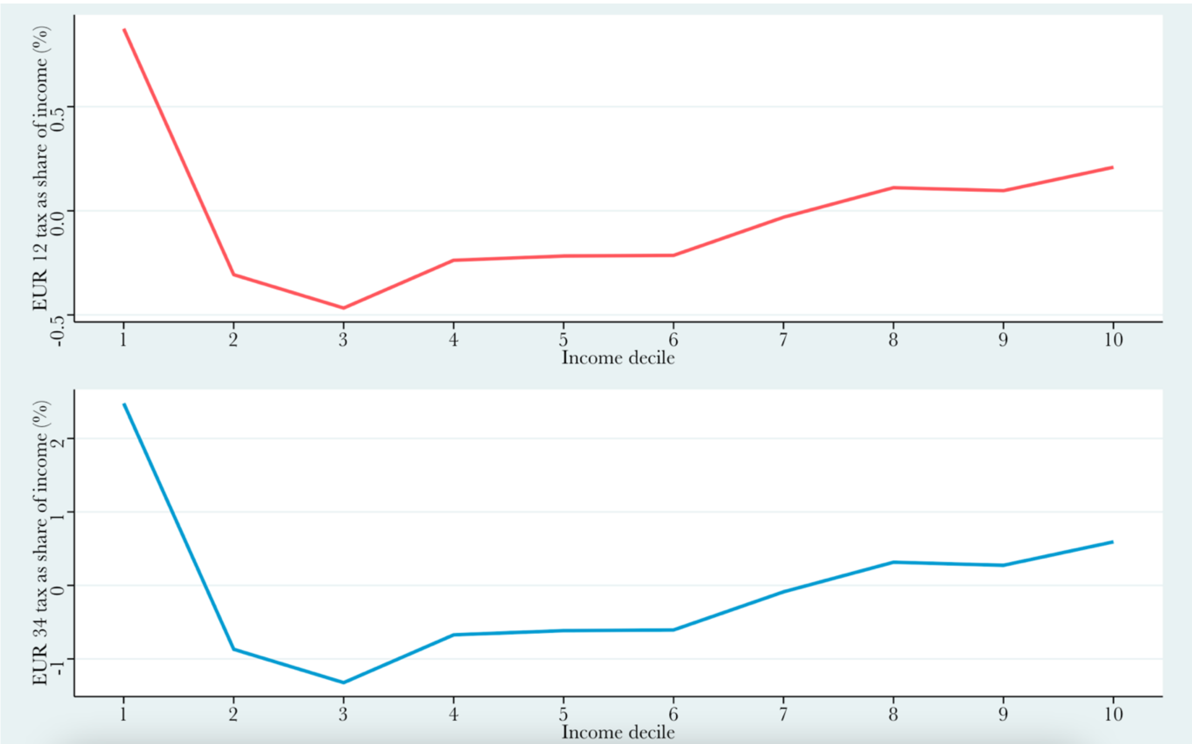

Figure 24. Vertical distributional effects of carbon pricing in Bulgaria with Rawlsian redistribution

5.2.3. Horizontal distributional effects

It is clear that carbon pricing would be vertically regressive in Bulgaria. Now, it is crucial to analyze the horizontal distributional effects, and see if within-decile effects are stronger than in the case of Romania. Figure 25 displays the incidence of both a EUR 12/tCO_2, and a EUR 34/tCO_2 across the two NUTS1 regions in Bulgaria. Given the existence of only two regions, the scope of the analysis is limited. The first tax would imply an average effort rate of the policy between 2.48-2.53% of annual regional consumption expenditure, while the second tax implies a similar effort rate between 7.03-7.19. Given the almost identical policy effort rates in the two Bulgarian NUTS1 regions, we infer that from the strict perspective of horizontal distributional justice, carbon pricing would be almost neutral.

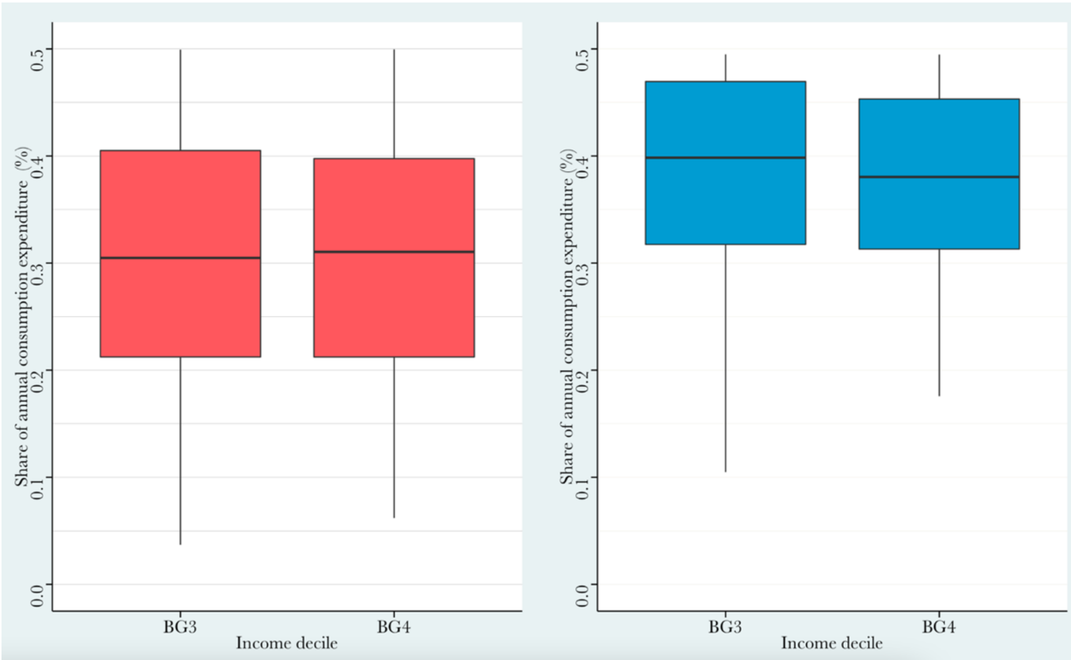

Figure 25. Horizontal distributional effects of carbon pricing in Bulgaria

Like in the case of Romania, carbon pricing is, however, regressive in Bulgaria, across both regions, as seen in Figure 26:

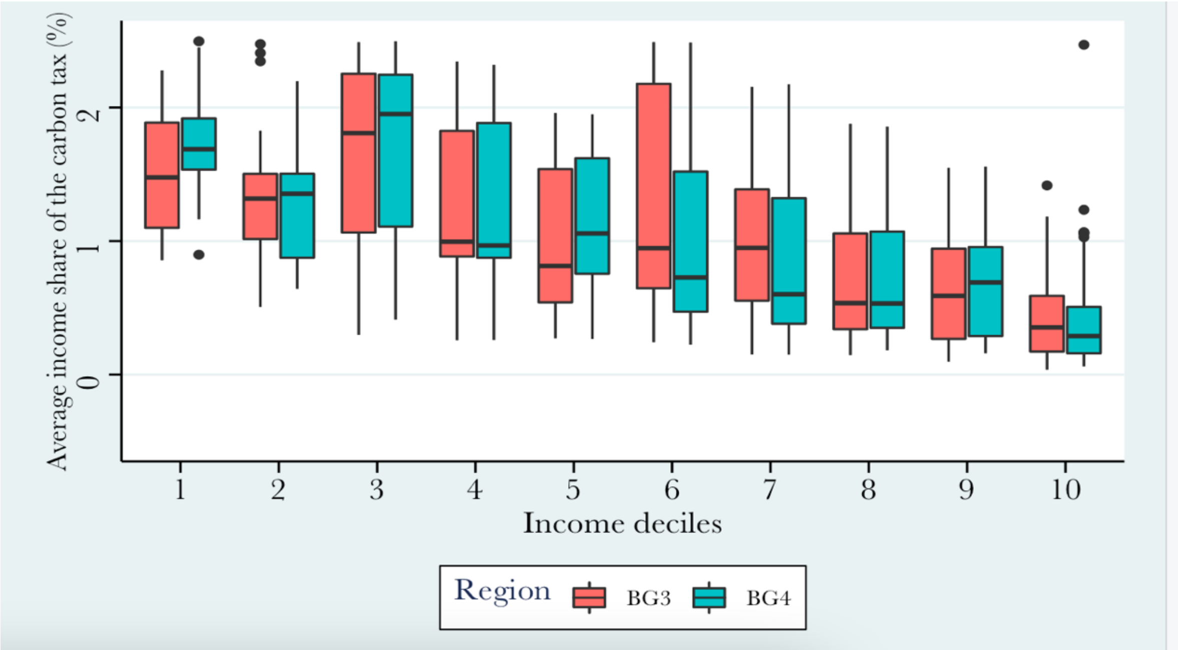

Figure 26. Distributional effects of carbon pricing in Bulgaria

6. DISCUSSION

The previous chapter describes the vertical and horizontal distributional effects of carbon pricing in Romania and Bulgaria, focusing on how different revenue-recycling schemes alleviate the regressive nature of a carbon tax. These findings confirm the initial hypothesis, that carbon pricing is regressive in EE countries in the absence of revenue-recycling mechanisms.

This is in line with the current literature on the topic. However, the results are more extreme: this is explained by the local particularities of Romania and Bulgaria in 2010, while the imputation of the carbon footprint might represent another source of uncertainty. A summary of these results, focusing on the vertical distributional effects, can be seen in the table below:

TAX DESIGN	ROMANIA	BULGARIA
EUR 12/tCO_2 WITHOUT REDISTRIBUTION	Regressive	Regressive
EUR 34/tCO_2 WITHOUT REDISTRIBUTION	Regressive	Regressive
EUR 12/tCO_2 WITH LUMP-SUM REDISTRIBUTION	Neutral	Regressive
EUR 34/tCO_2 WITH LUMP-SUM REDISTRIBUTION	Regressive	Regressive
EUR 12/tCO_2 WITH RAWLSIAN REDISTRIBUTION	Progressive	Neutral
EUR 34/tCO_2 WITH RAWLSIAN REDISTRIBUTION	Progressive	Neutral

Table 6. Summary of distributional effects

In this chapter, I build on the results of the microsimulations by discussing the optimal scenario for implementing a carbon tax in Romania and Bulgaria, and dealing with the expansion of the EU ETS. This discussion is based on a series of semi-structured interviews conducted with researchers, experts and political figures from the target countries. In particular, given its success as a revenue-recycling mechanism in ensuring tax neutrality, I discuss with the interview partners how Rawlsian redistribution could be framed in order to be publicly accepted.

6.1. Energy poverty

Romania and Bulgaria are some of the EU member states most affected by energy poverty (Kyprianou et al., 2019; Lenz & Grgurev, 2017; Neacsa et al., 2020). In Romania, 25% of the population was at risk of being energy-poor before the COVID-19 public health crisis. In Bulgaria, the number is estimated to be around 30-40% of the population. In the case of Romania, recent legal developments are trying to more precisely define the methodology for assessing whether somebody is energy poor; however, in Bulgaria, these debates have not entered the policy agenda.

Given these conditions, the interviewees, especially experts coming from national think-tanks, argue that the introduction of a national carbon tax or the significant expansion of the EU ETS needs to come alongside strong social policies. When asked about the potential of a green-dividend, interview partners were skeptical on whether this could be achieved in the current political climate. However, they recognized that the proposed Rawlsian-inspired revenue-recycling mechanism could potentially solve current energy poverty concern. One point that has been raised constantly concerns the need to frame the Rawlsian redistribution as a response to energy poverty. This would imply a specific government communications strategy that portrays revenue-recycling not as a welfare policy aiding the poor, but as an energy policy preventing price escalation in the liberalized markets. Using already internalized discursive strategies, such as combating energy poverty, the population would perceive the expansion of climate policy as solving current dilemmas. An additional advantage would be that this framing would further the discussion about carbon pricing and energy poverty, a crucial policy process development in Romania and Bulgaria.

6.2. Administrative constraints

Stakeholders were unanimous in recognizing the limited administrative capacity of both Romania and Bulgaria in dealing with a potential national carbon pricing scheme. The interviews revealed that neither country would be prepared to implement such a tax, and that currently, there are still problems in handling the responsibilities related to the EU ETS, even after 15 years since the debut of the cap-and-trade programme. More importantly, people working in the business sector stressed out that currently there is no coherent regime of using the revenues from the EU ETS, even if the EC imposes certain mandatory conditions on the spending patterns. When asked if Romania or Bulgaria would be capable of implementing a complex, targeted redistribution strategy for a national carbon tax, all the parties interviewed agreed that such a policy would probably not be feasible. The simplicity of the Rawlsian transfer based on a simple regressivity indicator was acknowledged as being beneficial in this regard.

Stakeholders also pointed out that citizens in both countries are not aware of why the costs of heating and electricity have gone up, and therefore it would be reasonable to expect that they would not be informed in the case in which a national carbon tax would further drive up their costs. The primary reason for the lack of communication on behalf of the authorities has to do with existing budgetary constraints, which keeps the agencies regulating the energy sector understaffed and unable to include affected stakeholders in the debates surrounding the climate policymaking process. While this is not something solvable given the scope of this thesis, it reinforces the idea that any ambitious climate policy needs to come complementary to a broad communications strategy.

6.3. Policymaking under uncertainty

Lastly, stakeholders accepted that given the current lack of data and the lack of expected improvements in data collection, both carbon taxation and revenue-recycling must be designed to accommodate uncertainty. Confronted with the methodology proposed in this thesis- using a simple indicator of regressivity for selecting who would benefit from a green dividend that compensates for the regressivity of carbon pricing, multiple stakeholders acknowledged this might be an effective fiscal strategy. They pointed out that many categories, especially the middle class, might perceive this as a form of *welfarism,* or even *socialism*.

Therefore, it is important to recognize that climate policymaking under uncertainty cannot be solved by policies that only reduce distributional uncertainty, as other dimensions of policymaking, such as public perception, remain intertwined. As previously mentioned, one suggested mechanism of dealing with the potential backlash would be to link revenue-recycling with the energy poverty concept, which might serve as a better, more targeted framing for the green dividend.

7. CONCLUSION

This thesis analyses the vertical and horizontal distributional effects of two carbon taxes, of EUR 12/tCO_2 and EUR 34/tCO_2, imposed in Romania and Bulgaria. I find both taxes regressive in terms of vertical distributional effects, while the horizontal distributional effects remain unclear. Given the lack of support for ambitious climate policy in EE, these results show that policymakers should pay special attention to how the revenue from any potential carbon taxes is distributed.

I show that while a uniform lump-sum transfer would reduce regressivity, especially in Romania, this recycling mechanism is suboptimal as it actually leads to financial gains for the most well-off in society. Following this, I propose a revenue-recycling mechanism based on Rawlsian normative considerations—only people disproportionately affected by the carbon tax would receive transfers. This mechanism makes the EUR 12/tCO_2 tax progressive in Romania and mostly progressive for Bulgaria. A series of interviews with experts, policymakers, political figures, and researchers from Romania and Bulgaria confirms the microsimulations' findings. Additionally, they reveal that the Rawlsian approach to climate policymaking under uncertainty is likely to be successful in the EE context only if the authorities craft a comprehensive communication strategy. One proposed solution would be to frame the Rawlsian-inspired approach as a response to the challenge of energy poverty.

By using microdata that has not been utilized by researchers in Eastern Europe, and an original imputation method which allows studying the incidence of carbon taxes across multiple dimensions, this master thesis fills a series of gap in the literature, which until now has been dominated by papers studying only vertical effects in Western European countries. Nevertheless, the lack of access to recent data has led to uncertainty regarding the results of the micro-simulations. Future research should aim to produce more sophisticated models of the economy, accounting both for demand and supply responses, and using more recent datasets.

BIBLIOGRAPHY

Aceleanu, M. I., Şerban, A. C., Ţîrcă, D. M., & Badea, L. (2018). The rural sustainable development through renewable energy. The case of Romania. *Technological and Economic Development of Economy*, *24*(4), 1408–1434.

Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The Environment and Directed Technical Change. *The American Economic Review*, *102*(1), 131–166. http://www.jstor.org/stable/41408771

Adler, C., Huggel, C., Orlove, B., & Nolin, A. (2019). Climate change in the mountain cryosphere: impacts and responses. *Regional Environmental Change*, *19*(5), 1225–1228. https://doi.org/10.1007/s10113-019-01507-6

Alam, A., Murthi, M., Yemtsov, R., Murrugarra, E., Dudwick, N., Hamilton, E., & Tiongson, E. (2005). *Growth, poverty, and inequality: Eastern Europe and the former Soviet Union*. The World Bank.

Aldy, J. E., & Stavins, R. N. (2012). The Promise and Problems of Pricing Carbon: Theory and Experience. *The Journal of Environment & Development*, *21*(2), 152–180. https://doi.org/10.1177/1070496512442508

Allen, M. R., Frame, D. J., Huntingford, C., Jones, C. D., Lowe, J. A., Meinshausen, M., & Meinshausen, N. (2009). Warming caused by cumulative carbon emissions towards the trillionth tonne. *Nature*, *458*(7242), 1163–1166. https://doi.org/10.1038/nature08019

Anckar, C. (2008). On the applicability of the most similar systems design and the most different systems design in comparative research. *International Journal of Social Research Methodology*, *11*(5), 389–401.

Araar, A., Dissou, Y., & Duclos, J.-Y. (2011). Household incidence of pollution control policies: A robust welfare analysis using general equilibrium effects. *Journal of Environmental Economics and Management*, *61*(2), 227–243. https://doi.org/https://doi.org/10.1016/j.jeem.2010.12.002

Arlinghaus, J. (2015). *Impacts of carbon prices on indicators of competitiveness: A review of empirical findings*.

Atkinson, A., & Stern, N. H. (1974). Pigou, Taxation and Public Goods. *Review of Economic Studies*, *41*(1), 119–128. https://econpapers.repec.org/RePEc:oup:restud:v:41:y:1974:i:1:p:119-128.

Baran, I., Dumitrescu, L., & Pescaru, R. A. (2016). Thermal rehabilitation technology and the nearly zero-energy buildings. Romanian representative education buildings-case study.

Procedia Technology, *22*, 358–364.

Baranzini, A., Van den Bergh, J. C. J. M., Carattini, S., Howarth, R. B., Padilla, E., & Roca, J. (2017). Carbon pricing in climate policy: seven reasons, complementary instruments, and political economy considerations. *Wiley Interdisciplinary Reviews: Climate Change*, *8*(4), e462.

Barnes, P. (2001). *Who owns the sky?: our common assets and the future of capitalism* (Issue 363.7392 B261). Island Press.

Basto, S., Thompson, K., Grime, J. P., Fridley, J. D., Calhim, S., Askew, A. P., & Rees, M. (2018). Severe effects of long-term drought on calcareous grassland seed banks. *Npj Climate and Atmospheric Science*, *1*(1), 1. https://doi.org/10.1038/s41612-017-0007-3

Baumol, W. (1972). On Taxation and the Control of Externalities. *American Economic Review*, *62*(3), 307–322. https://econpapers.repec.org/RePEc:aea:aecrev:v:62:y:1972:i:3:p:307-22

Beck, M., Rivers, N., Wigle, R., & Yonezawa, H. (2015). Carbon tax and revenue-recycling: Impacts on households in British Columbia. *Resource and Energy Economics*, *41*, 40–69. https://doi.org/https://doi.org/10.1016/j.reseneeco.2015.04.005

Berg-Schlosser, D., & De Meur, G. (2009). Comparative research design: case and variable selection. *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*, 19–32.

Berry, A. (2019). The distributional effects of a carbon tax and its impact on fuel poverty: A microsimulation study in the French context. *Energy Policy*, *124*, 81–94. https://doi.org/https://doi.org/10.1016/j.enpol.2018.09.021

Blonz, J., Burtraw, D., & Walls, M. A. (2011). How do the costs of climate policy affect households? The distribution of impacts by age, income, and region. *Resources for the Future Discussion Paper*, 10–55.

Bogdanov, B., & Tsanov, V. (2004). Measuring Poverty in Bulgaria. *Economic Thought Journal*, *4*, 3–27.

Bovenberg, A., & Goulder, L. H. (2001). Neutralizing the adverse industry impacts of CO2 abatement policies: what does it cost? In *Behavioral and distributional effects of environmental policy* (pp. 45–90). University of Chicago Press.

Bovenberg, A. L. (1999). Green Tax Reforms and the Double Dividend: an Updated Reader's Guide. *International Tax and Public Finance*, *6*(3), 421–443. https://doi.org/10.1023/A:1008715920337

Bovenberg, A. L., & De Mooij, R. A. (1994). Environmental levies and distortionary taxation. *The American Economic Review*, *84*(4), 1085–1089.

Bovenberg, A. L., & Goulder, L. H. (2001). Environmental Taxation and Regulation. In *NBER*

Working Papers.

Bowen, A. (2015). Carbon pricing: how best to use the revenue. *Policy Brief, Grantham Research Institute on Climate Change and the Environment*.

Boyce, J. K. (2018). Carbon pricing: effectiveness and equity. *Ecological Economics*, *150*, 52–61.

Boyce, J. K., & Riddle, M. (2007). Cap and dividend: how to curb global warming while protecting the incomes of American families. *PERI Working Papers*, 108.

Brännlund, R., & Nordström, J. (2004). Carbon tax simulations using a household demand model. *European Economic Review*, *48*(1), 211–233. https://doi.org/https://doi.org/10.1016/S0014-2921(02)00263-5

Brookings. (2018). *Romania: Thriving cities, rural poverty, and a trust deficit*.

Bureau, B. (2011). Distributional effects of a carbon tax on car fuels in France. *Energy Economics*, *33*(1), 121–130. https://doi.org/https://doi.org/10.1016/j.eneco.2010.07.011

Burtraw, D., Sweeney, R., & Walls, M. (2009). The incidence of US climate policy: alternative uses of revenues from a cap-and-trade auction. *National Tax Journal*, 497–518.

Carruthers, J. (1990). A Rationale for the Use of Semi-structured Interviews. *Journal of Educational Administration*.

Coase, R. H. (2000). *The Problem of Social Cost BT - Classic Papers in Natural Resource Economics* (C. Gopalakrishnan (ed.); pp. 87–137). Palgrave Macmillan UK. https://doi.org/10.1057/9780230523210_6

Coggan, A., Whitten, S. M., & Bennett, J. (2010). Influences of transaction costs in environmental policy. *Ecological Economics*, *69*(9), 1777–1784.

Conefrey, T., Fitz Gerald, J. D., Valeri, L. M., & Tol, R. S. J. (2013). The impact of a carbon tax on economic growth and carbon dioxide emissions in Ireland. *Journal of Environmental Planning and Management*, *56*(7), 934–952. https://doi.org/10.1080/09640568.2012.709467

Council, N. R. (2011). *Understanding Earth's deep past: Lessons for our climate future*. national academies Press.

Cremer, H., Gahvari, F., & Ladoux, N. (1998). Externalities and optimal taxation. *Journal of Public Economics*, *70*(3), 343–364. https://doi.org/https://doi.org/10.1016/S0047-2727(98)00039-5

Cretu, A.-F. (2016). *Income inequality in Romania: a comprehensive assessment1*.

Crowley, K. (2013). Pricing carbon: the politics of climate policy in Australia. *WIREs Climate Change*, *4*(6), 603–613. https://doi.org/10.1002/wcc.239

Czyżewski, B., & Kryszak, Ł. (2018). Impact of different models of agriculture on greenhouse gases (GHG) emissions: A sectoral approach. *Outlook on Agriculture*, *47*(1), 68–76.

Davis, L., & Knittel, C. (2019). Are Fuel Economy Standards Regressive? *Journal of the Association of Environmental and Resource Economists*, *6*(S1), S37–S63. https://econpapers.repec.org/RePEc:ucp:jaerec:doi:10.1086/701187

Dediu, M. (2009). *Financial Crisis Effects on Romanian Economy*.

Devlin, R. A., & Grafton, R. Q. (1998). *Economic rights and environmental wrongs: property rights for the common good*. CW Henderson Publisher.

Dinan, T. M., & Rogers, D. L. (2002). Distributional effects of carbon allowance trading: how government decisions determine winners and losers. *National Tax Journal*, 199–221.

Doltu, C., & Duhaneanu, M. (2012). Romania's recovery after the Economic Crisis. *Journal of Global Initiatives: Policy, Pedagogy, Perspective*, *6*(2), 10.

Dorband, I. I., Jakob, M., Kalkuhl, M., & Steckel, J. C. (2019). Poverty and distributional effects of carbon pricing in low- and middle-income countries – A global comparative analysis. *World Development*, *115*, 246–257. https://doi.org/https://doi.org/10.1016/j.worlddev.2018.11.015

Dorsch, M., Flachsland, C., & Kornek, U. (2018). *Enhancing climate policy ambition using strategic transfers: allowance allocation and revenue spending in the EU ETS*. Working paper.

Dorsch, M. J., Flachsland, C., & Kornek, U. (2020). Building and enhancing climate policy ambition with transfers: allowance allocation and revenue spending in the EU ETS. *Environmental Politics*, *29*(5), 781–804. https://doi.org/10.1080/09644016.2019.1659576

Drever, E. (1995). *Using Semi-Structured Interviews in Small-Scale Research. A Teacher's Guide*. ERIC.

Duguleană, C. (2011). Effects of the economic crisis in Romania. *SEER: Journal for Labour and Social Affairs in Eastern Europe*, 17–25.

Duwe, M., Smith, L. O., Donat, L., Velten, E. K., & Jirouš, F. (2014). Assessment of climate change policies in the context of the European Semester. *Country Report: Bulgaria (Covering the Period between February 2013 and November 2013)*.

Elkerbout, M., Egenhofer, C., Núñez Ferrer, J., Catuti, M., Kustova, I., & Rizos, V. (2020). The European Green Deal after Corona: Implications for EU climate policy. *CEPS Policy Insights*, *2020–06*.

Fischer, C., & Pizer, W. (2019). Horizontal Equity Effects in Energy Regulation. *Journal of the Association of Environmental and Resource Economists*, *6*(51).

Frölicher, T. L., Fischer, E. M., & Gruber, N. (2018). Marine heatwaves under global warming. *Nature*, *560*(7718), 360–364. https://doi.org/10.1038/s41586-018-0383-9

Frondel, M., Kussel, G., & Sommer, S. (2019). Heterogeneity in the price response of residential electricity demand: A dynamic approach for Germany. *Resource and Energy Economics*, *57*(C), 119–134. https://econpapers.repec.org/RePEc:eee:resene:v:57:y:2019:i:c:p:119-134

Fullerton, D., Cronin, J. A., & Sexton, S. (2019). Vertical and Horizontal Redistributions from a Carbon Tax and Rebate. *Journal of the Association of Environmental and Resource Economists*, *6*(S1).

Fullerton, D., & Heutel, G. (2007). The general equilibrium incidence of environmental taxes. *Journal of Public Economics*, *91*(3–4), 571–591.

Fullerton, D., & Heutel, G. (2011). Analytical general equilibrium effects of energy policy on output and factor prices. *The BE Journal of Economic Analysis & Policy*, *10*(2).

Galgóczi, B. (2020). Just transition on the ground: Challenges and opportunities for social dialogue. *European Journal of Industrial Relations*, *26*(4), 367–382.

Gherasim, C. (2020). *New year, old problems for one of EU's poorest places*. New Year, Old Problems for One of EU's Poorest Places.

Godar, J., Persson, U. M., Tizado, E. J., & Meyfroidt, P. (2015). Towards more accurate and policy relevant footprint analyses: Tracing fine-scale socio-environmental impacts of production to consumption. *Ecological Economics*, *112*, 25–35. https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.02.003

Grainger, C. A., & Kolstad, C. D. (2010). Who pays a price on carbon? *Environmental and Resource Economics*, *46*(3), 359–376.

Grasso, M. (2004). *Climate change: the global public good* (Working Papers, Issue 75). University of Milano-Bicocca, Department of Economics. https://econpapers.repec.org/RePEc:mib:wpaper:75

H., G. L. (1995). Effects of Carbon Taxes in an Economy with Prior Tax Distortions: An Intertemporal General Equilibrium Analysis. *Journal of Environmental Economics and Management*, *29*(3), 271–297. https://econpapers.repec.org/RePEc:eee:jeeman:v:29:y:1995:i:3:p:271-297

Hassett, K. A., Mathur, A., & Metcalf, G. E. (2009). The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis. *The Energy Journal*, *30*(2), 155–177. http://www.jstor.org/stable/41323238

Haug, C., Eden, A., & de Oca, M. M. (2018). Addressing the distributional impacts of carbon pricing policies. *Berlin, Adelphi*.

Hegyi, A., Dico, C., & Calatan, G. (2016). Construction sustainability with adobe bricks type elements. *Urbanism. Arhitectura. Constructii*, *7*(2), 147.

IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate

Change. In *Ipcc* (Vol. AR5).

IPCC. (2018). *Global warming of 1.5°C. IPCC Special Report 15.*

Irimie, D. L. (2010). Rules for reporting and accounting of GHG emissions in the LULUCF sector. Implications for the forest policy in Romania. *Revista Pădurilor*, *125*(3), 24–31.

Ivanova, D., Vita, G., Steen-Olsen, K., Stadler, K., Melo, P. C., Wood, R., & Hertwich, E. G. (2017). Mapping the carbon footprint of EU regions. *Environmental Research Letters*, *12*(5), 054013. https://doi.org/10.1088/1748-9326/aa6da9

Jackson, E. A., & Jabbie, M. (2019). Understanding market failure in the developing country context. In *Decent Work and Economic Growth: Encyclopedia of Sustainable Development Goals* (pp. 1–10). Cham: Springer Nature Switzerland.

Jakob, M., Steckel, J. C., & Edenhofer, O. (2014). Consumption- Versus Production-Based Emission Policies. *Annual Review of Resource Economics*, *6*(1), 297–318. https://doi.org/10.1146/annurev-resource-100913-012342

Jentsch, A., & Beierkuhnlein, C. (2008). Research frontiers in climate change: Effects of extreme meteorological events on ecosystems. *Comptes Rendus Geoscience*, *340*(9), 621–628. https://doi.org/https://doi.org/10.1016/j.crte.2008.07.002

Jiroudková, A., Anna, L., Strielkowski, W., & Slosarcík, I. (2015). EU accession, transition and further integration for the countries of Central and Eastern Europe. *Economics & Sociology*, *8*(2), 11.

Kallbekken, S., Kroll, S., & Cherry, T. L. (2011). Do you not like Pigou, or do you not understand him? Tax aversion and revenue-recycling in the lab. *Journal of Environmental Economics and Management*, *62*(1), 53–64.

Kaplow, L. (1985). *Horizontal equity: measures in search of a principle*. National Bureau of Economic Research.

Kerkhof, A. C., Moll, H. C., Drissen, E., & Wilting, H. C. (2008). Taxation of multiple greenhouse gases and the effects on income distribution: A case study of the Netherlands. *Ecological Economics*, *67*(2), 318–326. https://doi.org/https://doi.org/10.1016/j.ecolecon.2007.12.015

Klenert, D., & Mattauch, L. (2016). How to make a carbon tax reform progressive: The role of subsistence consumption. *Economics Letters*, *138*, 100–103.

Klenert, D., Mattauch, L., Combet, E., Edenhofer, O., Hepburn, C., Rafaty, R., & Stern, N. (2018). Making carbon pricing work for citizens. *Nature Climate Change*, *8*(8), 669–677. https://doi.org/10.1038/s41558-018-0201-2

Klinsky, S., Roberts, T., Huq, S., Okereke, C., Newell, P., Dauvergne, P., O'Brien, K., Schroeder, H., Tschakert, P., & Clapp, J. (2017). Why equity is fundamental in climate change policy research. *Global Environmental Change*, *44*, 170–173.

Kyprianou, I., Serghides, D. K., Varo, A., Gouveia, J. P., Kopeva, D., & Murauskaite, L. (2019). Energy poverty policies and measures in 5 EU countries: A comparative study. *Energy and Buildings*, *196*, 46–60.

Lambert, P. J. (1992). The distribution and redistribution of income. In *Current issues in public sector economics* (pp. 200–226). Springer.

Lenz, N. V., & Grgurev, I. (2017). Assessment of energy poverty in new european union member states: The case of Bulgaria, Croatia and Romania. *International Journal of Energy Economics and Policy*, *7*(2).

Levi, S. (2021). Why hate carbon taxes? Machine learning evidence on the roles of personal responsibility, trust, revenue-recycling, and other factors across 23 European countries. *Energy Research & Social Science*, *73*, 101883.

Levi, S., Flachsland, C., & Jakob, M. (2020). Political Economy Determinants of Carbon Pricing. *Global Environmental Politics*, *20*(2), 128–156.

Liang, Q.-M., & Wei, Y.-M. (2012). Distributional impacts of taxing carbon in China: Results from the CEEPA model. *Applied Energy*, *92*, 545–551. https://doi.org/https://doi.org/10.1016/j.apenergy.2011.10.036

Lockwood, M. (2013). The political sustainability of climate policy: The case of the UK Climate Change Act. *Global Environmental Change*, *23*(5), 1339–1348.

Mandle, J. (2009). *Rawls's' A Theory of Justice': An Introduction*. Cambridge University Press.

Marica, I. (2018). *Romania has one of the highest income inequality ratios in the EU*. Romania Insider.

Markandya, A. (2011). Equity and Distributional Implications of Climate Change. *World Development*, *39*(6), 1051–1060. https://doi.org/https://doi.org/10.1016/j.worlddev.2010.01.005

Mathur, A., & Morris, A. C. (2014). Distributional effects of a carbon tax in broader US fiscal reform. *Energy Policy*, *66*, 326–334.

McDaniel, P. R., & Repetti, J. R. (1992). Horizontal and vertical equity: the Musgrave/Kaplow exchange. *Fla. Tax Rev.*, *1*, 607.

McGregor, G. R., Ferro, C. A. T., & Stephenson, D. B. (2005). *Projected Changes in Extreme Weather and Climate Events in Europe BT - Extreme Weather Events and Public Health Responses* (W. Kirch, R. Bertollini, & B. Menne (eds.); pp. 13–23). Springer Berlin Heidelberg. https://doi.org/10.1007/3-540-28862-7_2

McIntosh, M. J., & Morse, J. M. (2015). Situating and constructing diversity in semi-structured interviews. *Global Qualitative Nursing Research*, *2*, 2333393615597674.

Melenciuc, S. (2019). *Romania's poor people are the poorest in the EU*. Business Review.

Metcalf, G. E. (1999). A distributional analysis of green tax reforms. *National Tax Journal*, 655–681.

Mickwitz, P., Aix, F., Beck, S., Carss, D., Ferrand, N., Görg, C., Jensen, A., Kivimaa, P., Kuhlicke, C., & Kuindersma, W. (2009). *Climate policy integration, coherence and governance*. irstea.

Milanovic, B., & Ersado, L. (2012). Reform and inequality during the transition: an analysis using panel household survey data, 1990–2005. In *Economies in transition* (pp. 84–108). Springer.

Mintchev, V., Boshnakov, V., & Naydenov, A. (2010). SOURCES OF INCOME INEQUALITY: EMPIRICAL EVIDENCE FROM BULGARIA. *Economic Studies*, *19*(4).

Minx, J. C., Wiedmann, T., Wood, R., Peters, G. P., Lenzen, M., Owen, A., Scott, K., Barrett, J., Hubacek, K., Baiocchi, G., Paul, A., Dawkins, E., Briggs, J., Guan, D., Suh, S., & Ackerman, F. (2009). INPUT–OUTPUT ANALYSIS AND CARBON FOOTPRINTING: AN OVERVIEW OF APPLICATIONS. *Economic Systems Research*, *21*(3), 187–216. https://doi.org/10.1080/09535310903541298

Mirrlees, J. A., & Adam, S. (2010). *Dimensions of tax design: the Mirrlees review*. Oxford University Press.

Muresan, A. A., & Attia, S. (2017). Energy efficiency in the Romanian residential building stock: A literature review. *Renewable and Sustainable Energy Reviews*, *74*, 349–363.

Musgrave, R. A. (1990). Horizontal equity, once more. *National Tax Journal*, 113–122.

Neacsa, A., Panait, M., Muresan, J. D., & Voica, M. C. (2020). Energy poverty in European Union: Assessment difficulties, effects on the quality of life, mitigation measures. some evidences from Romania. *Sustainability*, *12*(10), 4036.

Network, C. A. (2018). Off Target—Ranking of EU Countries' Ambition and Progress in Fighting Climate Change. In *Climate Action Network Europe: Brussels, Belgium*.

Newcomer, K. E., Hatry, H. P., & Wholey, J. S. (2015). Conducting semi-structured interviews. *Handbook of Practical Program Evaluation*, *492*.

Nordhaus, W. (2019). Climate change: The ultimate challenge for economics. *American Economic Review*, *109*(6), 1991–2014.

Nunez, S., Arets, E., Alkemade, R., Verwer, C., & Leemans, R. (2019). Assessing the impacts of climate change on biodiversity: is below 2 °C enough? *Climatic Change*, *154*(3), 351–365. https://doi.org/10.1007/s10584-019-02420-x

Oancea, B., Andrei, T., & Pirjol, D. (2017). Income inequality in Romania: The exponential-Pareto distribution. *Physica A: Statistical Mechanics and Its Applications*, *469*, 486–498.

OECD. (2015). *Economic Consequences of Climate Change*. OECD Publishing.

Ohlendorf, N., Jakob, M., Minx, J. C., Schröder, C., & Steckel, J. (2018). *Distributional Impacts of Climate Mitigation Policies - a Meta-Analysis* (Discussion Papers of DIW Berlin, Issue 1776). DIW Berlin, German Institute for Economic Research. https://econpapers.repec.org/RePEc:diw:diwwpp:dp1776

Ohlendorf, N., Jakob, M., Minx, J. C., Schröder, C., & Steckel, J. C. (2021). Distributional Impacts of Carbon Pricing: A Meta-Analysis. *Environmental and Resource Economics*, *78*(1), 1–42.

Ourbak, T., & Tubiana, L. (2017). Changing the game: the Paris Agreement and the role of scientific communities. *Climate Policy*, *17*(7), 819–824. https://doi.org/10.1080/14693062.2017.1348331

Parry, I. (2015). *Carbon tax burdens on low-income households: a reason for delaying climate policy?*

Parry, I. (2020). Increasing carbon pricing in the EU: Evaluating the options. *European Economic Review*, *121*, 103341.

Parry, I. W. H. (1995). Pollution taxes and revenue-recycling. *Journal of Environmental Economics and Management*, *29*(3), S64–S77.

Parry, I. W. H. (1997). Environmental taxes and quotas in the presence of distorting taxes in factor markets. *Resource and Energy Economics*, *19*(3), 203–220. https://doi.org/https://doi.org/10.1016/S0928-7655(96)00012-7

Parry, I. W. H. (2004). Are emissions permits regressive? *Journal of Environmental Economics and Management*, *47*(2), 364–387. https://doi.org/https://doi.org/10.1016/j.jeem.2003.07.001

Pashardes, P., Pashourtidou, N., & Zachariadis, T. (2014). Estimating welfare aspects of changes in energy prices from preference heterogeneity. *Energy Economics*, *42*, 58–66. https://doi.org/https://doi.org/10.1016/j.eneco.2013.12.002

Pelman, R., Ma, Y., McGilvray, J., & Common, M. (2011). *Natural Resource and Environmental Economics* (3rd ed.). Pearson Education Limited.

Peñasco, C., Anadón, L. D., & Verdolini, E. (2021). Systematic review of the outcomes and trade-offs of ten types of decarbonization policy instruments. *Nature Climate Change*, 1–9.

Pigou, A. (1960). *The Economics of Welfare* (4th ed.).

Poterba, J. M. (1991). *Tax policy to combat global warming: on designing a carbon tax*. National Bureau of Economic Research.

Ramstein, C., Dominioni, G., Ettehad, S., Lam, L., Quant, M., Zhang, J., Mark, L., Nierop, S., Berg, T., & Leuschner, P. (2019). *State and trends of carbon pricing 2019*. The World Bank.

Rausch, S., Metcalf, G. E., & Reilly, J. M. (2011). Distributional impacts of carbon pricing: A general equilibrium approach with micro-data for households. *Energy Economics*, *33*, S20–S33. https://doi.org/https://doi.org/10.1016/j.eneco.2011.07.023

Rawls, J. (2009). *A theory of justice*. Harvard university press.

Roach, T. (2021). Dynamic carbon dioxide taxation with revenue-recycling. *Journal of Cleaner Production*, *289*, 125045.

Sabato, S., & Fronteddu, B. (2020). A socially just transition through the European Green Deal? *ETUI Research Paper-Working Paper*.

Sajeewani, D., Siriwardana, M., & Mcneill, J. (2015). Household distributional and revenue-recycling effects of the carbon price in Australia. *Climate Change Economics*, *6*(03), 1550012.

Schlosser, C. A., Gao, X., Strzepek, K., Sokolov, A., Forest, C. E., Awadalla, S., & Farmer, W. (2013). Quantifying the likelihood of regional climate change: a hybridized approach. *Journal of Climate*, *26*(10), 3394–3414.

Sokolov, A. P., Stone, P. H., Forest, C. E., Prinn, R., Sarofim, M. C., Webster, M., Paltsev, S., Schlosser, C. A., Kicklighter, D., & Dutkiewicz, S. (2009). Probabilistic forecast for twenty-first-century climate based on uncertainties in emissions (without policy) and climate parameters. *Journal of Climate*, *22*(19), 5175–5204.

Sommer, M., & Kratena, K. (2017). The Carbon Footprint of European Households and Income Distribution. *Ecological Economics*, *136*, 62–72. https://doi.org/https://doi.org/10.1016/j.ecolecon.2016.12.008

Speck, S. (1999). Energy and carbon taxes and their distributional implications. *Energy Policy*, *27*(11), 659–667. https://doi.org/https://doi.org/10.1016/S0301-4215(99)00059-2

Steininger, K., Lininger, C., Droege, S., Roser, D., Tomlinson, L., & Meyer, L. (2014). Justice and cost effectiveness of consumption-based versus production-based approaches in the case of unilateral climate policies. *Global Environmental Change*, *24*, 75–87.

Stern, N. (2006). *Stern Review on the Economics of Climate Change*.

Stoiciu, V. (2012). Austerity and structural reforms in Romania. *International Policy Analysis*, 1–7.

Tang, Q., Zhang, X., & Francis, J. A. (2014). Extreme summer weather in northern mid-latitudes linked to a vanishing cryosphere. *Nature Climate Change*, *4*(1), 45–50. https://doi.org/10.1038/nclimate2065

Tiezzi, S. (2005). The welfare effects and the distributive impact of carbon taxation on Italian households. *Energy Policy*, *33*(12), 1597–1612. https://doi.org/https://doi.org/10.1016/j.enpol.2004.01.016

Todor, A. (2014). Romania's austerity policies in the European context. *Romanian Journal of Society and Politics*, *9*(1), 25–42.

Todor, A. (2015). ROMANIANS SOCIAL PROTECTION PROGRAMS REFORM DURING THE ECONOMIC CRISIS. *Romanian Journal of Society and Politics*, *10*(2), 79–93.

Tol, R. S. J., Downing, T., Kuikk, O., & Smith, J. (2003). *Distributional Aspects of Climate Change Impacts* (ENV/EPOC/GSP(2003)14).

Tovar Reaños, M. A., & Wölfing, N. M. (2018). Household energy prices and inequality: Evidence from German microdata based on the EASI demand system. *Energy Economics*, *70*, 84–97. https://doi.org/https://doi.org/10.1016/j.eneco.2017.12.002

van den Bijgaart, I., Gerlagh, R., & Liski, M. (2016). A simple formula for the social cost of carbon. *Journal of Environmental Economics and Management*, *77*, 75–94. https://doi.org/https://doi.org/10.1016/j.jeem.2016.01.005

Vandyck, T., & Van Regemorter, D. (2014). Distributional and regional economic impact of energy taxes in Belgium. *Energy Policy*, *72*, 190–203. https://doi.org/https://doi.org/10.1016/j.enpol.2014.04.004

Vuille, M., Carey, M., Huggel, C., Buytaert, W., Rabatel, A., Jacobsen, D., Soruco, A., Villacis, M., Yarleque, C., Elison Timm, O., Condom, T., Salzmann, N., & Sicart, J.-E. (2018). Rapid decline of snow and ice in the tropical Andes – Impacts, uncertainties and challenges ahead. *Earth-Science Reviews*, *176*, 195–213. https://doi.org/https://doi.org/10.1016/j.earscirev.2017.09.019

Webster, M., Sokolov, A. P., Reilly, J. M., Forest, C. E., Paltsev, S., Schlosser, A., Wang, C., Kicklighter, D., Sarofim, M., & Melillo, J. (2012). Analysis of climate policy targets under uncertainty. *Climatic Change*, *112*(3–4), 569–583.

West, S. E., & Williams, R. C. (2004). Estimates from a consumer demand system: implications for the incidence of environmental taxes. *Journal of Environmental Economics and Management*, *47*(3), 535–558. https://doi.org/https://doi.org/10.1016/j.jeem.2003.11.004

Wier, M., Birr-Pedersen, K., Jacobsen, H. K., & Klok, J. (2005). Are CO2 taxes regressive? Evidence from the Danish experience. *Ecological Economics*, *52*(2), 239–251. https://doi.org/https://doi.org/10.1016/j.ecolecon.2004.08.005

Williams, R., Gordon, H., Burtraw, D., Carbone, J., & Morgenstern, R. D. (2015). The Initial Incidence of a Carbon Tax Across Income Groups. *National Tax Journal*, *68*(1), 195–214. https://econpapers.repec.org/RePEc:ntj:journl:v:68:y:2015:i:1:p:195-214

APPENDIX

For further information regarding this masters' thesis, please access the following repository: https://github.com/vladsurdea/DistributionalEffectsCarbonPricing. This contains:

- An abridged version of the datasets used.
- R and Python code for pre-processing, modelling the microsimulations and generating plots.
- Interview guidelines, invitations and notes.

Statement of Authorship

I hereby confirm and certify that this master thesis is my own work. All ideas and language of others are acknowledged in the text. All references and verbatim extracts are properly quoted and all other sources of information are specifically and clearly designated.

DATE: 16.04.2021

NAME: SURDEA-HERNEA VLAD

SIGNATURE: