Glocal politics:
Local political parties and GHG emissions in Norwegian municipalities, 2009-2021

Juni Jørgenvåg Lund

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Department of Comparative Politics
University of Bergen

Abstract

Climate change is an increasingly pressing and politically salient issue. Green parties have emerged in many Western democracies as a response to this and other environmental challenges. Climate change mitigation has also become an integral part of the agenda of most established political parties. The local level is often argued to be an important arena for climate change mitigation. Despite this, research on the political drivers of greenhouse gas (GHG) emissions is usually conducted at the national level. In this thesis, I study the effect of political parties on GHG emissions at the local level in Norway. The thesis thereby contributes to three broad fields within political science. The first is the role political parties have in affecting political outcomes. The second is environmental politics, specifically the political efforts to reduce GHG emissions. Thirdly, this work contributes to the study of local politics. I thereby investigate what role political parties and politics at the local level can play in climate change mitigation. This opens for testing classical theories about political parties in an "untraditional" setting: climate politics at the local level. I combine partisan theory with a multidimensional party family approach and hypothesize that leftist parties and Green parties will lead to lower levels of GHG emissions. By employing panel regression, I find that the Green Party (MDG), the far left Red Party (Rødt), and maybe more surprisingly, the Center Party (Senterpartiet) seem to be associated with lower levels of emissions. When tested using the method panel matching, only MDG is found to have a significant effect on the levels of emissions. The findings are relevant to our understanding of responses to climate change at different levels of policy making. They indicate that parties matter, and so do local level politics.

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Abbreviations and Norwegian names

Ap	Arbeiderpartiet, Labor Party
EC	Executive committee of the municipal council
Frp	Fremskrittspartiet, far right party
Høyre	Conservative party
Krf	Christian Democratic party
MDG	Miljøpartiet de grønne, Green Party
Miljødirektoratet	The Norwegian Directorate for the Environment
Rødt	Far left/communist party
Senterpartiet	Centre Party
SV	Sosialistisk Venstreparti, Socialist Left Party
Venstre	Liberal party

1 Introduction

Climate change is probably the largest collective action dilemma the world has ever knowingly faced (Ostrom 2010, 355). “Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020” (IPCC 2022). Global climate change has several detrimental consequences. It makes sufficient food production difficult, it leads to the extinction of species, increases the likelihood of pandemics, accelerates antimicrobial resistance along with other predicted and unpredicted dire consequences (Abbass et al. 2022). The emission of greenhouse gases (GHG) is the dominant driver of climate change (Rosa and Dietz 2012). To reduce GHG emissions is therefore of paramount importance and urgency.

Emissions levels are to a large extent driven by population size and economic activity (Rosa and Dietz 2012; Boyce and He 2022; Martínez-Zarzoso, Bengochea-Morancho, and Morales-Lage 2007). However, political factors, such as democracy, corruption levels, number of veto players and civil society activity weaken the relationship between economic activity and emissions (Lægreid and Povitkina 2018). The relationship between economic factors and populations size on the one hand and GHG emissions on the other is therefore not deterministic. Political tools can be used to affect the levels of GHG emissions.

Climate change is a “glocal” problem (Di Gregorio et al. 2019, 64; Jorgenson et al. 2019, 8). It is global in the sense that it is a problem that affects the earth as a whole and that solutions depend upon global cooperation. But it is also local in the sense that the consequences are experienced locally and depend upon local solutions. Local action is of major importance for the achievement of climate change mitigation (Isabel Azevedo, Horta, and Leal 2017, 204). To reach carbon neutrality, national governments need support from public bodies at all jurisdictional levels (Salvia et al. 2021). Cities, counties and towns worldwide have emerged as climate change policy leaders, sometimes to fill a void created by national level inaction (Armstrong 2022; Mocca, Friesenecker, and Kazepov 2020). Local level climate change mitigation is, however, constrained by a number of factors such as authority distributions between local, national and global governments and fragmented local governance structures (Neij and Heiskanen 2021).

Norway is an underperformer when it comes to reducing emissions. The EU, Sweden, Denmark and Finland have all reduced their emissions with over 30 percent from 1990 to 2020. Norway has only reduced emissions with 4.2 percent in the same time period (UNFCCC Time Series - Annex 1). Norwegian municipalities have strong competencies regarding land-use planning, waste collection and handling, and traffic regulation. The local political level in Norway both can and do play an important role when it comes to reducing emissions. There is also a huge variation in emissions developments in the municipalities. In the time period 2009 to 2021, some municipalities have reduced their emissions by more than 30 percent, while others have had massive increases (Miljødirektoratet 2022b). This variation is probably due to a large number of different factors, and the ambition of this thesis is not to cover all of these. What I do want to investigate is whether *some* of this variation can be explained by local level politics. More specifically, can it be explained by the presence of different political parties? Do politics actually matter in this very important issue? In this thesis I seek to answer the research question:

Do local political parties affect greenhouse gas emissions in Norway?

Acknowledging that municipal emissions are likely to be affected by population, economic activity and national and international politics, I still hypothesize that which political parties govern at the local level plays a role. I perform both OLS regression analysis and the relatively new method panel matching as proposed by Imai et al. (2021) in order to test the relationship between the political parties and emissions. The two methods imply testing this relationship in slightly different ways. While regression analysis allows for testing the effect of an increase in the seat share of parties, panel matching tests the effect of party presence or party majority without considering differences within these categories. First, I hypothesize that the presence, or an increase, of Green Party (MDG) representatives in the executive committee (EC) of the municipal council leads to lower levels of emissions. Secondly, I hypothesize that a leftist party majority, or an increase in the seat share of the leftist parties, also leads to lower levels of GHG emissions. I expect that the effect of the leftist parties will be different, and that the Socialist Left Party (SV) and the Red Party (Rødt) will be associated with lower levels of emissions than the Labor Party (Ap). In addition to the total municipal emissions levels, I also investigate in which sectors the effect of political parties on GHG emissions is most pronounced. As the municipalities have competencies in the handling of waste, traffic regulation, and land-use planning I hypothesize that the presence of Green and leftist parties will be found in the sectors "Waste and Sewage", "Heating", and "Road Traffic".

The results of the analyses support some but not all of these hypotheses. In both the regression and the panel matching analysis, the Green party is associated with lower levels of GHG emissions. The leftist parties as a group are, however, not associated with lower emissions levels in any of the analyses. When looking at the leftist parties separately, the regression analysis shows that the Red Party is associated with lower levels of emissions, while the Labor Party and the Socialist Left Party are not. However, the relationship between the Red Party and lower emissions levels is not as evident in the panel matching analysis. When looking into the different sectors, the results show that the Red Party and the Green Party are indeed associated with lower levels of emissions from waste and sewage, heating, and road traffic.

1.1 Academic contribution

This thesis contributes to three broad fields of research. First of all, it is situated within comparative environmental politics and climate change research. Secondly, it contributes to the research on local level politics. Thirdly, it builds upon the research on political parties and partisan politics, although in a relatively unconventional setting: local climate change mitigation. To my knowledge it is the first quantitative analysis of the effect of political parties on GHG emissions at the local political level.

The academic contributions of this thesis are mainly empirical. I employ a political outcome (GHG emissions), rather than a political output (e.g. climate change mitigation policies) as a dependent variable. This makes it possible to say something about the effectiveness of political actions. The local political level has been studied to a much lesser degree than the national level. The results from the analysis tell us something about the importance of both political parties and the local political level. If political parties at the local level are able to affect GHG emissions, this means that both political parties and the local political level do matter.

The thesis does however also entail a methodological contribution. As far as I know, panel matching has not been employed to test the effect of politics on GHG emissions. Panel matching allows for employing matching methods and Difference-in-Difference estimators on panel data (Imai et al. 2021). This allows for causal inference with a larger degree of certainty than regression analysis. In the study of political impacts on GHG emissions the distance between the alleged cause and effect is long and complicated, and causal relationships are thus difficult to identify. Methodological approaches that facilitate causal inference might therefore be especially useful.

1.2 Societal contribution

In addition to the academic contributions, this thesis also entails a societal contribution. As the thesis is concerned with the effect of political parties, going into details about the effect of specific policies is beyond the scope of this thesis. Still it is to some extent an assessment of "policy packages." By participating in a wider discussion about political measures to reduce GHG emissions, this thesis contributes to a better understanding of the relationship between politics and climate change. This can help strengthen and accelerate political climate change mitigation.

Unlike many other public goods the municipalities provide, the reductions of emissions cannot be felt directly. If inhabitants are to be able to hold their elected representatives responsible, they must have a way to evaluate their performance. In a way, all types of information about political outcomes can be seen as positive for the democratic process. Voters will emphasize different issues to different degrees. However, more scientifically based insights about which political outcomes are related to which parties can make informed decisions easier.

1.3 Chapter structure

This thesis proceeds as follows. The next chapter introduces comparative environmental politics as a field, and discusses how the issue of climate change mitigation can be viewed in a comparative politics perspective. It also presents the literature on the role of the local political level in climate change mitigation, and why Norway is an interesting case to study. Chapter 3 presents the theoretical basis used in the thesis. Partisan theory and a multidimensional party family approach is used to form hypotheses regarding which of the political parties we can expect to have an effect on GHG emissions. Chapter 4 presents some alternative or additional explanations for differences in the levels of GHG emissions. The explanations discussed here are later used as control variables in the statistical analyses. Chapter 5 concerns the data used in the statistical analyses, and operationalizations and descriptive statistics are presented and discussed. In Chapter 6 I explain and discuss the methodological approaches used, and why these methods are a good combination for testing my hypotheses. I first present the regression analysis, and discuss the choices I have made and why I have made them. Then I explain the approach used when I employ panel matching. Chapter 7 presents the result from the regression analysis and panel matching. In the final chapter I discuss the findings of the statistical analyses in light of partisan theory and the party family approach. The hypotheses guide the discussion, and I also discuss the limitations of this thesis along with some possible pathways for future research.

2 Background

This section gives a brief overview of the literature on comparative environmental politics which allows me to position my thesis in the relevant field. First, I present comparative environmental politics as a research field. Secondly, I discuss how climate change, as an all-encompassing, intergenerational, and global issue, challenges liberal, capitalistic, democratic nation-states and democratic political theory. I then explore what we know about the role of local political bodies in creating environmental policies. Finally, I present Norwegian municipalities and their functions in relation to climate change mitigation.

2.1 Comparative environmental politics

Comparative environmental politics is a strand of comparative politics that investigates national and sub-national differences and similarities in environmental policy and environmental outcomes, and attempts to explain their origin (McBeath and Rosenberg 2006, 5). Climate change politics forms part of the broader field of environmental politics. However, climate change mitigation is a unique policy matter as it depends upon decarbonization which requires a fundamental restructuring of existing institutions (Farstad 2018, 699). In one way, climate change mitigation is a political matter in the same way as other political issues. It can be seen as a public good that can be prioritized or de-prioritized compared to other public goods and economic constraints. However, some characteristics of climate change pose a unique challenge for politics and political science. Environmental political theory opposes the idea that environmental challenges can be seen as just a particular "issue area" for government policy as well as the longstanding focus of political theory upon the rational, liberal individual human (Gabrielson et al. 2016, 5). Climate change does, if taken seriously, force researchers and politicians to rethink established practice and consensus.

It is increasingly clear that climate change mitigation requires transformative action across all areas of social, economic, and political life (Bulkeley and Newell 2023). Democracy, and especially the existing liberal democratic model is often closely associated with capitalism, short-term orientation, and distance from community engagement, all of which can be seen as detrimental to the environment (Böhmelt, Böker, and Ward 2016, 1274). Some have questioned whether it is possible to solve the issue of climate change within the political, social and economic system we have today. It can be argued that while many elements of contemporary state practice clearly have a negative impact on the environment, these should be considered historically contingent rather than inherent features of statehood. Contrastingly, it has been claimed that there is a distinctive historical and structural relationship between capitalism, growth, and the state (Paterson 2016, 479). Some have argued that there is a decoupling of economic growth on one side, and resource use and emissions on the other side. There is, however, no empirical evidence indicating that an absolute decoupling can be achieved, and if it were possible, it is highly unlikely that this decoupling is happening fast enough (Hickel and Kallis 2020). It might, therefore, be the case that sufficient climate change mitigation is incompatible with democratic, capitalistic nation-states as we know them today.

The relationship between climate change and democracy is not straightforward, and democracy has been claimed to be both detrimental and inducive for climate change mitigation. Climate change challenges democratic nation-states because of its urgency, its future-oriented, intergenerational and international scope, and the possible need for expert rule rather than popular deliberation (Talbot 2016, 225). The short term nature of representative democracy might make politicians unwilling to tackle the long-term issue of environmental politics (Helliesen 2022, 4). The positive effects of reducing emissions are not felt immediately. People might be more driven by short term objectives. Consequently, climate change mitigation is a difficult issue psychologically, which might make it less likely for people and politicians to prioritize. Moreover, politicians will want to achieve tangible results within the relatively short election period. This can be difficult with policies for reducing emissions, as they can require fundamental infrastructural change that takes longer times, and the positive effects of reducing emissions are not directly visible. Democratic decision-making may therefore not be the most efficient way to combat climate change.

The issue of climate change challenges the legitimacy of existing democracies. A principle in democratic theory is that all those affected by a decision should be able to have a say in making it (Dahl 1970, 64). Democratic theories are often concerned with the internal decision-making arrangements, taking for granted that there is a well-defined group to which the question of democratic governance arises (Whelan 1983, 15-16). When it comes to climate change, all those affected are not having a say in decision-making. GHG emissions do not relate to human-made borders. Moreover, greenhouse gases remain in the atmosphere for generations, and the effects of global warming might be irreversible. Emissions or regulation of emissions affect the globe as a whole, in addition to future generations. These factors make it impossible for all those affected to have a say in political decisions regarding GHG emissions.

Still, there is a belief that democracies perform better than autocracies when it comes to environmental issues (Böhmelt, Böker, and Ward 2016, 1273). Bättig and Bernauer (2009, 285) theorize that both the demand for and supply of climate change mitigation policies are larger in democracies. They find that the effect of democracy on climate mitigation policies is positive, while the effect on actual emissions reductions is ambiguous. Povitkina (2018) finds that democracy is only associated with lower GHG emissions when corruption levels are low. Povitkina and Bolkvadze (2019) show that state capacity is equally important as democracy to ensure environmental public goods. Von Stein (2022) argues that whether democracy is positive or negative for the environment depends on several factors. One of the things she emphasizes is that if electoral accountability is to have a positive effect, it hinges upon whether citizens privilege environmental protection as a policy objective (Von Stein 2022, 353). These findings indicate that the effect of democracy might be positive but that it depends upon several other factors. Moreover, whether democracies can do *enough* to mitigate detrimental climate change remains questionable. However, given the seriousness and urgency of solving the climate crisis, building on our existing structures seems more fruitful than designing new ones (Eckersley 2004, 91).

Assuming that climate change mitigation is possible within the democratic nation-state, how can such an environmental or "green state" be conceptualized? Duit (2016) compares the environmental state to the welfare state. Human-induced climate change is, according to the former World Bank chief economist Nicholas Stern, "the biggest market failure the world has ever seen" (Bättig and Bernauer 2009, 282). While the welfare state tries to protect humans from the negative externalities of the market, the environmental state seeks to protect the environment from the negative externalities of the market. Of course, the environmental state also protects humans, as we depend upon the environment in order to survive in the long run. In the environmental state, de-commodification refers to the protection of non-renewable natural resources from capitalization by the market (Duit 2016, 71). There are parallels between the growth of the environmental state and the welfare state's earlier development (Duit, Feindt, and Meadowcroft 2016, 9). And just as the massive expansion of welfare institutions significantly changed the modern state, one can expect that the environmental state will change the state significantly (Duit, Feindt, and Meadowcroft 2016, 11). The reduction of emissions can be understood as a public good the state can provide in the same way as the state can provide poverty reduction and social security.

2.2 Local politics and climate change

It is increasingly recognized that the subnational level ought to, and do play an important role when it comes to climate change mitigation (Echebarria et al. 2018, 1290; Talbot 2016, 213; Hooghe and Marks 2010, 17; I Azevedo and Leal 2021; Armstrong 2022). The local political level as an arena for action in transboundary environmental issues was widely introduced in the Brundtland Report of 1987, and municipal concern and involvement in the climate change issue can be traced back to the 1990s and the start of international concerns over GHG emissions levels (Fuhr, Hickmann, and Kern 2018, 1). Municipal governments began to take action on climate change before their regional counterparts (Bulkeley 2011, 465). It has been argued that the physical characteristics of the energy systems and the regulatory competences of local authorities make the local level an appropriate level for action when it comes to climate change mitigation (Isabel Azevedo and Leal 2020, 1).

However, there is little empirical evidence that indicate that the climate policies enacted locally significantly reduce emissions. Common policy action often entail joining climate protection networks, making plans and setting goals (Armstrong 2022, 160). These actions do not necessarily result in the reduction of emissions. Isabel Azevedo, Horta, and Leal (2017) investigate the empirical connection between local action plans and climate change mitigation in Portugal, Sweden, and the United Kingdom. They do not find a significant impact of local plans on local emissions. Looking more directly at emissions at the local level, instead of intentions to reduce emissions, is therefore useful.

The local level acts within a multilevel governance framework and their ability to affect emissions depend on several institutional factors. Hooghe, Marks, and Schakel (2010) introduce a framework for measuring and understanding regional and local level authority. A regional or local government has some extent of formal authority over certain actions in a particular jurisdiction. These local political bodies vary concerning (1) the territorial scope of their authority, (2) the depth of their authority, and (3) over which spheres of action they exercise authority (Hooghe, Marks, and Schakel 2010, 6-7). The first form of variation relates to whether a local political body exercises authority only within its borders or co-determines the exercise of authority in the country as a whole. The second aspect measures to what degree other government levels can constrain a local government. The third aspect concerns the portfolio of policies which the local government can exercise authority over. To affect emissions, local level governments must have sufficient depth of authority in addition to being able to affect spheres where reductions are possible.

The literature on the local level and climate change focuses primarily on cities. This makes sense, as cities and towns are sites of high energy consumption and high waste production (Gustavsson, Elander, and Lundmark 2009, 59). Cities comprise more than half of the world's population and are responsible for three-quarters of the world's GHG emissions (Mi et al. 2019). Reducing emissions in cities is, therefore, especially important. The local level is also often associated with climate change *adaptation* rather than *mitigation* (Aguiar et al. 2018). Municipalities are crucial in climate change adaptation as they are the political level closest to implementation. Also often mentioned is the local level's role in transnational climate networks (Eisenack and Roggero 2022; Gustavsson, Elander, and Lundmark 2009). However, the role of policy creation at the local level has been less studied, despite the local political level's importance as a policy provider and actor in reducing emissions. Moreover, widening the scope to include not only cities is also valuable. Although cities make up most of the emissions, there are still substantial emissions from other municipalities. Emissions reductions must happen across all sectors in all countries, and non-city municipalities also need to reduce their emissions.

Local governments perform two roles in reducing greenhouse gas emissions: transforming their own organization and initiating and aiding local transformation (Amundsen et al. 2018, 23). The local political level is responsible for large-scale services such as health care and education and are large employers. The organization of municipal services can therefore significantly impact the total amount of emissions.

In addition to transforming their own organization, local political bodies can affect other parts of society to reduce emissions. Municipal governments vary greatly in their possibility to affect emissions outside their own organization. Bulkeley (2011, 468) does, however, present some policy areas relevant to emissions where municipalities generally are thought to be able to have an effect. The first is through energy supply and management. Secondly, transport, through the regulation of road traffic and through the provision of public transport, is in general an authority given to municipalities (I Azevedo and Leal 2021; Bulkeley and Betsill 2005). The third policy field is land-use planning, where local governments can prioritize low-emission solutions (Amundsen et al. 2018, 26; Bulkeley and Betsill 2005). Lastly, municipalities are generally responsible for waste collection and management (Bulkeley and Betsill 2005). Municipal governments are therefore particularly expected to affect emissions from energy supply and management, transport, land-use, and waste.

The analogy of the welfare state is useful here as well. The role of the local level in the environmental state can be compared to that of the local level in the welfare state. A defining feature of the social-democratic welfare state has been centralized state hierarchies. Sellers and Lidström (2007) do, however, argue that strong local governments and a centralized system are not mutually exclusive and that social-democratic welfare states are characterized by powerful local governments that preceded the welfare state. It is theorized that strong local governments are inducive for egalitarian, universalistic welfare states since they can adapt the provision of public goods to the local community and function as a link between civil society and politics (Sellers and Lidström 2007, 611). These qualities can also be positive for the local level as a provider of environmental politics. Many of the changes necessary to mitigate climate change, especially those concerning people's everyday lives, must be made locally. Moreover, by handling climate change issues at the local level, they can become more engaging to the population as they can discuss and affect policies to a larger extent, and solutions might therefore seem more proximate and feasible (Prugh, Costanza, and Daly 2000). Local governments can, in the same way they have in the welfare state, play an important role in the environmental state. Climate policies made at the local political level can more easily be adapted to local settings. They can also possibly be more responsive as this governmental level is closer to the inhabitants.

The local level does not act independently of the other political levels, and it makes sense to understand climate change mitigation efforts at the local level in a multilevel governance framework (Bulkeley and Betsill 2005, 43). Climate policy has shifted towards a complex landscape characterized by multilevel governance, polycentricity, and orchestration (Eisenack and Roggero 2022, 1). Multilevel governance is cooperation in providing collective goods at diverse scales (Hooghe and Marks 2020, 820). Polycentric systems are systems where multiple public and private organizations jointly affect collective benefits and costs. A polycentric approach challenges the presumption that only the largest scale is important in providing public goods (Ostrom 2012, 356). The orchestration concept combines elements of “top down” and “bottom up” solutions to collective action problems. Private actors, NGOs, and sub-national governance levels can take action toward mitigating climate change, and the national or international level can perform an orchestrating role (Hale and Roger 2014). These concepts are helpful in order to capture the multifaceted challenges and solutions regarding climate change mitigation. Reducing emissions across all political levels is crucial in order to avoid policy gaps between local action plans and national policy frameworks.

It is often at the local level that policy ideas are first formed and where some of the most innovative solutions are first tried out (Schreurs 2008, 346). The local level can therefore be thought of as an arena for experimenting. What is learned in the experiments can then be used in other municipalities, nationally and internationally. Considering all political levels allows for bottom-up policy learning, where initiatives at the local level influence national politics, and top-down support, where enabling policy frameworks empower the local level (Corfee-Morlot et al. 2009, 3). This thesis focuses exclusively on the local political level. As most research on climate change politics has nation-states as units, this thesis contributes to the knowledge of the complex system of political climate change mitigation by providing insights into the relatively understudied local political level.

2.3 Norwegian municipalities

Norway is an interesting case regarding the politics of reducing emissions. Norway is a resourceful country with access to clean energy sources, such as hydro power, that has made ambitious emissions reduction goals. Norway is also situated in the Arctic, where the effects of global warming are more rapid, visible, and alarming (Eckersley 2016, 190-191). In some sense, one could therefore expect Norway to prioritize emissions reductions. However, Norway has an oil-dependent economy and performs better concerning political commitment than actual GHG emissions reductions (Bättig and Bernauer 2009, 283; Krange, Kaltenborn, and Hultman 2019). Norway has been a leader in terms of mitigation ambitions and had a goal of reducing emissions by 30 percent from 1990 levels by 2020 while also being a nation with a high economic dependency on fossil fuels (Eckersley 2016, 183). The majority of European countries have decreased their emissions from 1990 levels, and the average decrease has been around 19 percent (Talbot 2016, 213). Norway, on the other hand, has only reduced emissions by 4.2 percent (UNFCCC Time Series - Annex 1). The contradiction between the role as an international climate policy leader and a major petroleum exporter with little actual reduction in emissions is sometimes called the "Norwegian paradox" (Lahn 2019, 5; Farstad and Aasen 2022, 3).

The framework proposed by Hooghe, Marks, and Schakel (2010) is useful for assessing the authority of Norwegian municipalities. As mentioned, in order to affect emissions levels, the local political level must have sufficient depth of authority. Moreover, whether they are able to affect emissions and in which sectors they are able to affect emissions depend upon which spheres of action they have authority over.

Although Norway is a unitary state, the municipalities are responsible for local infrastructure and essential welfare services (Fiva, Folke, and Sørensen 2018, 9). Moreover, the Norwegian government has ascribed a formal role to the municipalities in achieving the 2030 Agenda (Reinar and Lundberg 2023, 2-3). Norwegian municipalities may undertake any function not executed by another public body. In addition to this, the municipalities also have specific mandatory functions (Baldersheim 2022). On the Local Authority Index (LAI), Norwegian municipalities are given the highest possible score when it comes to institutional depth. Institutional depth is defined as "[t]he extent to which local government is formally autonomous and can choose the tasks they want to perform" (Codebook LAI 2.0 2022). This measure corresponds well with the notion of depth of authority. Norwegian municipalities are therefore expected to have sufficient depth of authority to affect emissions within the municipality.

Norwegian municipalities have authority over several spheres of action where we can expect reductions in emissions to happen. The typical municipal responsibilities mentioned before are also, to a large degree, found in Norway. The municipalities are exclusively responsible for collecting and handling consumption waste in Norway (Forurensingsloven 1981). Norwegian municipalities also have some authority regarding road traffic, although the main responsibility is vested in the state level. Municipalities can differentiate between rush hour and non-rush hour toll prices, decide on parking fees and, from 2015, create low-emission zones. In 2017 there was a change in legislation that allowed the municipalities to create environmentally differentiated toll fees (Sousa Santos et al. 2020, 259). The Norwegian municipalities have the main responsibility for land-use planning and must create a municipal planning strategy at least once each election term (Plan- og bygningsloven 2008, §10-1). Energy supply and management are affected by many policy fields, and authority is distributed between the different governmental levels. Norwegian municipal governments can affect energy use through regulation of their own energy use and by facilitating more efficient energy use by individuals and businesses within the municipalities. Norway, therefore, fits well with the general picture of municipal authority.

Norway has 356 municipalities. Municipal elections happen every fourth year, and the last election was in 2019. Elections to the municipal councils use St. Lagües modified method to calculate the distribution of seats ("Valoppgjer ved kommunestyreval" 2023). The municipal councils vary in size, and the six smallest have only 11 representatives, while the largest municipality has 77 representatives. Except for Oslo and Bergen, the municipal councils appoint an executive committee (*formannskap*). Elections to the executive committee (EC) happen through proportional elections in the municipal council (Saxi 2015, 10). This means that parties in the municipal council will be close to proportionally represented in the executive committee, although less so for the smaller parties. The size of the executive committees varies between 3 and 19 representatives. Oslo and Bergen, the two largest cities, employ a parliamentary system.

3 Theory: the role of political parties

In this chapter, I discuss the possible impact of political parties on GHG emissions through a partisan theory framework. In its simplest form, partisan theory stipulates that the political parties in power affect the policies formed. I begin by describing partisan theory and how this school of thought has developed. Partisan theory is paired with a multidimensional party family approach, acknowledging that political parties vary along more than one political axis. Followingly, I use these theories to form hypotheses regarding the effect of the political parties on environmental outcomes.

In a seminal study, Hibbs (1977) finds a difference between left-wing and right-wing governments in how they handle the trade-off between unemployment and inflation, known as the Philips curve. By looking at 12 European and North American nations, he shows that countries generally governed by left-wing governments have low unemployment and high inflation, while countries that have mostly been governed by right-wing parties have high unemployment and low inflation. Moreover, he conducts a time-series analysis of Britain and the United States, finding that unemployment has gone down under Labour and Democratic governments and up under Conservative and Republican governments (Hibbs 1977, 1467). Hibbs refers to several studies showing that poor people both prefer and generally have an economic advantage of the nation having low unemployment rather than low inflation (Hibbs 1977, 1468). The rich are more negatively impacted by inflation than by high unemployment rates, as they have more financial capital and tend to hold more secure jobs (Hibbs 1992, 363). Based on the premise that the mass constituencies of the political parties are distinguished by class and income, the conclusion of the article is that the policies pursued by right- and left-wing governments “are broadly in accordance with the objective economic interests and subjective preferences of their class-defined core political constituencies” (Hibbs 1977, 1468). The premise of partisan theory is thus that political parties have core constituencies that they act on behalf of and that this affects the policies decided upon. Consequently, partisan models imply a shift in policies and outcomes correlated with changes in party control of governments (Hibbs 1992).

Left and right parties are expected to have different policy positions regarding welfare state provisions due to, among other things, the parties' position on the tradeoff between taxes and public services (Schmidt 2021, 299). Differences in political outcomes from left and right parties on welfare state provisions have been empirically supported in several studies. In a review article examining 107 peer-reviewed articles and books covering high-income countries, Falkenbach, Bekker, and Greer (2020) find that an overwhelming majority of the literature sample suggests that left parties expand the welfare state without cutting benefits, while right parties tend to cut benefits.

Empirical findings also indicate that local political parties affect political outcomes in the Scandinavian countries. In a study of Swedish municipalities, Sandberg (2023, forthcoming) finds that left-wing parties increase tax revenue, public employment, and immigration. Fiva, Folke, and Sørensen (2018) find that in Norway, a left-party majority at the local level leads to an increase in property taxation and higher childcare spending. Blom-Hansen, Monkerud, and Sørensen (2006) investigate the effect of local party ideology in Denmark and Norway and find local parties are able to affect the revenue levels. The effect is, however, bigger in Denmark than in Norway.

Partisan theory is often contrasted with a Downsian approach, where parties are rational and vote-seeking rather than policy-seeking (Downs 1957). The central hypothesis is that political parties formulate policy strictly to gain votes and that people vote according to who they think will provide them the highest utility income (Downs 1957, 137-138). Any policy difference is due to different assumptions about the voters' preferences. The result is that all parties will converge around the median voter, and there will be no substantial difference in policy outcomes. However, by taking a deeper dive into the seminal article by Downs (1957), it becomes clear that his rational choice approach might not be as incompatible with a partisan framework as is sometimes assumed. Downs acknowledges that, in reality, both voters and politicians have imperfect knowledge. The parties create and adhere to ideologies because voters cannot be fully informed about all policy domains. When parties link themselves to an ideology, voters can decide upon a policy package. This is rational for the voters as they can invest less time and energy in finding the party that will give them the most utility, and it is rational for the parties as they can attract voters more easily. Once a party has an ideology, they must form policies in accordance with this ideology in order to be reliable and seem credible to the voters (Downs 1957, 142).

Downs (1957) is often cited for the median-voter theorem. It is true that if we expect all parties to converge around the median voter, we would not expect to see different policy outcomes from different parties. But the median-voter theorem is only one of several possibilities presented by Downs. First of all, this theorem assumes a two-party system. Moreover, Downs states that: "Hotelling's conclusion that the parties in a two-party system inevitably converge to the center does not necessarily hold true" (Downs 1957, 142). He includes a model for multiparty systems, where the distribution of voters is thought to be multimodal, and each party is motivated to "stay at its mode" in order to differentiate itself from the other parties (Downs 1957, 143). This implies that "voters in multiparty systems have a wider range of choice than voters in two-party systems and that each choice is more definitely linked to some ideological position" (Downs 1957, 144). Thus, whether political parties are theorized to care about policy outcomes, or they are purely office seeking, we can expect parties to matter for political outcomes in a multiparty system.

Downs' rational approach assumes that parties forms policies in accordance with an ideology with the goal of gaining more votes. A rational approach where parties are not purely vote-seeking is, however, also possible. Alesina (1987) presents a model where parties act rationally, but where they differ in what they consider as good or bad, and what weight they give to different outcomes. This is based on a partisan assumption that parties care about the effects of policies, and that the parties have different objectives and incentives (Alesina 1987, 652).

The classic partisan theory is built around the left-right political axis. Environmental politics is considered a part of "new politics", meaning that it cuts across the classical left-right partisan alignment (Carter 2013, 74; Knill, Debus, and Heichel 2010, 304). Therefore, the left-right dimension seems insufficient when considering climate change and environmental politics. However, partisan theory does not have to include only the left-right dimension. The core of the partisan model is that parties are rational, act on behalf of their voters, and that they are able to affect policies and policy outcomes. This can be applied to any classification of parties, and here I will employ a multidimensional party family approach.

Several classifications of parties can be used to explain the different parties' stances toward environmental issues. Mair and Mudde (1998) argue that party families should be characterized based on origin and ideology, and this follows a historical-developmental approach in accordance with Rokkan (1970). Von Beyme (1985) refers to Stein Rokkan's types of conflicts that have emerged in Europe through the different stages of development as explanations for the different types of party families formed. Von Beyme's party family approach is multi-dimensional as it takes a basis in societal conflicts and formative moments to explain the emergence of different party families (Jahn 2022, 481). When considering the effect of political parties on environmental issues, Jahn (2022) argues in favor of a multi-dimensional understanding of party families based on which societal conflicts were the basis of the formation of parties.

One of the societal conflicts Von Beyme includes is ecological movements against a growth-oriented society (Von Beyme 1985, 24). The widely used GAL-TAN dimension is a "new politics" dimension ranging from green/alternative/libertarian (GAL) on one side and traditional/authoritarian/nationalist (TAN) on the other side (Hooghe, Marks, and Wilson 2002, 966). This dimension sees green politics as being part of a bundle, where parties based on an alternative and libertarian ideology also can be expected to be concerned with mitigating climate change. A political dimension, or cleavage, between environmental concern and a prioritization of economic growth is an integral part of a contemporary multidimensional party family approach.

Parties are not only shaped by their origin and their ideology, and the opinions of the people that usually vote for them also play a role. It is increasingly acknowledged that different groups have varying preferences and that parties realign based on voter preferences rather than being explicitly linked to one class and representing what is allegedly their interests (Wenzelburger and Zohlnhöfer 2021, 1055-1056). This is often termed the "electoral turn". That means we can expect parties to differ not only according to their origin and ideology but also based upon the opinions of their core constituency. We can therefore expect parties with environmentally concerned voters to prioritize emissions-reducing policies.

Parties differ not only based on their political stance but also on their institutional roles. Katz and Mair (1995) observed the emergence of what they called cartel parties. The mass parties that represented whole sections of society based on class had turned into cartel parties. They were more actors on behalf of the state than on behalf of society, concerned with their own survival and security and likely to resemble one another (Katz and Mair 2009). This was the case for the established mainstream parties that had taken part in governing (Katz and Mair

2009, 760). The mainstream governing parties had gone from mass parties to catch-all parties, to cartel parties. The result of this is that the ties between the social groups the parties were once thought to represent and the parties have been weakened. This weakened tie makes the mainstream parties less responsive to the electorate. It might also entail that these parties have close ties to industry or businesses that oppose reductions in emissions. Additionally, governing parties are to some extent "responsible" for previous pollution and current un-green institutions. Taking a strong environmental stance and radically changing existing structures might therefore give the impression of hypocrisy or admitting previous mistakes. Leadership dominated parties may more easily sacrifice certain policy proposals in order to secure electoral support than parties dominated by activists (Wenzelburger and Zohlnhöfer 2021, 1062). The roles the different political parties have had and the way they are organized may, therefore, affect their effort to reduce emissions.

3.1 Green parties

Green parties were founded based on the emergence of environmental concern as a political issue in the 1970s and 1980s (Carter 2013, 73; Neumayer 2003, 204). They are based on the confrontation between environmental protection and economic growth (Jahn 2022, 479). Mitigating climate change is unarguably crucial in order to protect the environment, and emissions reduction is therefore at the core of the green ideology. Based on the ideology and the origins of the Green Party family, it is therefore highly likely that green representatives would prioritize to reduce emissions.

Political candidates might be directly motivated by policy outcomes, and a political group might seek to reduce emissions simply because they prefer to do so (Garmann 2014, 1-2). It is likely that people that become Green Party politicians have an intrinsic wish or feeling of responsibility to preserve the environment and mitigate climate change. They are dependent on the public to be elected, but once they are elected one can imagine that they act on behalf of this inherent ideology.

In addition to the ideological and origin based arguments for why green parties can be expected to have a decreasing effect on emissions, there are some structural factors that make it even more likely that they will be able to affect emissions. Green parties are relatively young parties. This can make it more likely that the connection between ideology and policy position is more straightforward compared to older, more institutionalized parties where organizational survival and internal disagreements between factions can play a larger role (Jahn 2022, 482). Put in other words, it is less likely that they have developed cartel-like structures. While we can imagine that the prioritization of cutting emissions has a high consensus within Green parties, other parties might have factions that have different opinions on where environmental issues should be on the priority list. Prioritizing emissions reduction should, therefore, not be a controversial issue within the Green party.

Green parties do not act in a vacuum, and their success might affect the strategies of other parties. Green parties can be regarded as an issue entrepreneur and a niche party, since they largely introduced environmental protection as a political issue. It is often assumed that the success of a niche party will make the established parties adopt the policies of the niche party to avoid losing voters to this party. As a comparable example, it has been shown that the rise of populist radical right parties makes other parties more restrictive towards immigration (Muis and Immerzeel 2017, 918). Abou-Chadi (2014) finds, however, that Green parties and populist radical right parties have different effects on mainstream parties. The established parties can also choose to de-emphasize environmental issues by fear of strengthening the "issue entrepreneur" by making their issue more salient (Abou-Chadi 2014, 417-418). The other parties might, therefore, prioritize emission reduction to a lesser degree when the Green Party grows. In that case, a larger share of Green representatives might not lead to lower levels, but maybe rather higher levels, of emissions. Consequently, Green parties' success in reducing emissions depends on the strategies the other parties choose.

3.2 Leftist parties

The left-right axis can also be helpful in explaining environmental outcomes, as leftist parties often are associated with positive environmental outcomes. Farstad (2018) finds that left-right ideology significantly explains the salience of climate change in party manifestos more than any other party characteristic. I will first present the theoretical arguments for a positive effect of leftist parties on the environment and then the empirical evidence for this relationship.

Neumayer (2003) lays out a theoretical argument for why leftist parties should be more concerned about the environment. These reasons are repeated in many of the later articles examining the effect of leftist parties on environmental outcomes. The main arguments found in the literature are that leftist parties (1) have a more environmentally concerned core constituency, (2) are more prone to lose votes to green parties, (3) are more comfortable with interventionists policies, and (4) have a core constituency that is more vulnerable to the damages caused by environmental degradation. I will now examine these arguments in closer detail.

The first reason leftist parties might take a more pro-environmental stance is that their voters are more concerned about the environment. Several studies indicate a strong linkage between environmental concern and a leftist political orientation at the individual level (Fisher et al. 2022; Dunlap, McCright, and Yarosh 2016; Hornsey et al. 2016; McCright 2010). Based on the idea that political parties realign their stance based on the opinions of their electorate, a more concerned core constituency is a reason for leftist parties to prioritize emission reductions to a larger extent. If leftist parties realign based on the preferences of their electorate, one can expect them to incorporate environmental issues.

That left parties are more environmentally concerned because of the opinion of their core voters might be a problematic argument. Issues might be politicized at the elite level, and voters change their policy stance according to their preferred party. This is especially the case for issues the public do not have a strong opinion about beforehand. This might therefore be a case of reciprocal causation, where political parties affect voters and voters affect political parties (Fisher et al. 2022, 2). By interviewing politicians in Denmark and Ireland, Ladrech and Little (2019) find that politicians try to align party stances according to public opinion. This indicates that policy preferences among leftist voters might be part of the cause of leftist parties' climate policy preferences.

Secondly, and closely related, is the fact that Green parties often place themselves on the left side of the left-right axis. Although Green parties have often claimed to be neither left nor right, they have often taken leftist positions on economic issues and have been widely regarded as left-wing (Carter 2013, 75). This means that leftist and Green parties are more likely to compete for voters (Schulze 2021, 47). To avoid losing voters to the Green Party or to other parties on the left with a strong environmental profile, mainstream leftist parties might strategically choose to incorporate environmental issues into their platforms. If one views parties as vote-maximizing rational actors, it makes sense that parties incorporate environmental issues to avoid losing votes to green parties. This is then especially true for leftist parties. Their voters are more likely to be concerned about the environment, and they are already close to the Green parties on the left-right axis, and their voters might therefore be more prone to leave for the Greens. However, according to the argument of Abou-Chadi (2014), leftist parties might also de-emphasize environmental issues in fear of making this issue more salient and thereby lose votes to the Green Party.

Thirdly, it has been argued that leftist parties might more readily accept the state interventions necessary to cut emissions. An ideology that wants the state to intervene to secure welfare and equality might also accept state interventions to ensure environmental welfare (Farstad 2018, 700; Schulze 2021, 41; Neumayer 2003, 204). This argument pertains to the parties' ideology and assumes that a leftist ideology is more compatible with climate change mitigation. The environmental state is understood as something similar to the welfare state, where the state protects the environment or individuals against the negative externalities of the market (Duit 2016). Leftist ideology is therefore thought to be more compatible with viewing the state as a tool for controlling the market.

Lastly, the working class, the traditional constituency of the left-wing parties, might be more vulnerable to environmental pollution than the rich (Neumayer 2003, 205; Garmann 2014, 2). Moreover, environmental policies often entail extra costs for businesses, which can make right-wing parties more opposed to these measures (Lim and Duit 2018, 221). Although this might be true in the long run with climate change, it may be a more plausible explanation for the incorporation of other environmental issues into left-wing party platforms.

Still, the alignment of environmental issues on the left-right axis is not straightforward, and there are several reasons why we might not expect the left to be especially environmentally friendly. It might be that leftist parties prioritize economic growth over environmental protection in order to secure employment for their working-class constituents (Knill, Debus, and Heichel 2010, 304; Schulze 2021, 46; Neumayer 2003). Reducing emissions might be costly and entail de-prioritizing, or even sacrificing, economic growth. If reducing emissions results in fewer workplaces and more unemployment, left parties can be expected to oppose these in accordance with the classic partisan argument of Hibbs (1977). Leftist parties, especially labor parties, were created in an industrial society, and their ideological basis was embedded in a Marxist ideology where more equality and better conditions for workers were to be achieved through technological progress and constant economic expansion (Jahn 2022, 483). Sacrificing economic growth and employment to secure environmental protection does, therefore, not seem compatible with the ideological origins of the traditional left. Moreover, cutting emissions will threaten jobs in highly polluting industries. These workplaces have traditionally been strongly unionized and, through this, highly connected to left parties through the unions (Neumayer 2003, 204). Left parties can therefore be expected to prioritize saving these workplaces over closing them down in order to cut emissions.

However, acknowledging that there exists more political dimensions than left-right means that what differs between the parties on the left is not only how "far" left they are. These parties represent different societal conflicts, and how they relate to environmental issues might therefore differ. With some alterations, the PACOGOV dataset is based on Von Beyme's party families. In the dataset, (post-)communist and left-socialist parties are grouped together, while the social democratic parties form their own party family (Schmidt et al. 2020). Jahn (2022) places the different parties on an expected growth-environment continuum, where communists and left socialists are placed closer to the green end than social democratic parties.

The leftist political parties belong to different party families. They might therefore relate to environmental issues in different ways. Working class voters are the core clientele of right-wing populist parties (Oesch 2008). Especially labor parties, which are based on the conflict between workers and employers, can be expected to compete with the radical right for voters. As a right-wing political orientation is connected to less climate concerned at the individual level, being less salient on environmental issues might therefore be a rational strategy for labor parties. Left libertarian values are grouped with green values on the GAL-TAN axis. Left libertarian parties might therefore be expected to reduce emissions to a larger extent than other leftist parties. Moreover, labor parties have been one of the major governing parties and were once a mass-party for the working class. These parties can therefore be expected to have developed more cartel-like structures.

Figure 3.1 The political parties according to the left-right axis

← left / right →								
Rødt	SV	Ap	MDG	Sp	KrF	Venstre	Høyre	FrP

Figure 3.2 The political parties according to the green/gray axis

←green / gray→							
Green	Communist/ Socialist left	Social democrats	Christian	Liberal	Non-Christian center parties	Conservative	Nationalist/ Right Populist
MDG	SV + Rødt	Ap	KrF	Venstre	Sp	Høyre	FrP

Note: The party families are placed according to (Jahn 2022).

Figure 3.1 shows the Norwegian political parties according to the left-right axis. The political parties considered leftist are Rødt (the Red Party), SV (the Socialist Left Party), and Ap (the Labor Party). Figure 3.2 shows the Norwegian political parties according to which party family they belong to and where this party family can be placed on a gray/green axis. This placement is based on Jahn (2022). Based on the theoretical background, the following hypotheses are formed:

*H1a: **More Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.*

*H1b: The **presence of Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.*

*H2a: **More leftist** party representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.*

*H2b: A **leftist party majority** in the executive committee of the municipal council leads to lower GHG emissions.*

H2c: The leftist parties will be associated with lower emissions levels to different extents, and the Socialitst Left party (SV) and the Red Party (Rødt) will be associated with more emissions reductions than the Labor Party (Arbeiderpartiet).

Based on the Norwegian municipalities' competencies, it can also be hypothesized which sectors municipal political parties will be able to affect. Through the task of land-use planning and a wide range of other competencies, municipal governments are expected to be able to affect most emissions sectors. However, as mentioned in sub-chapter 2.3, the municipalities have specific authority over road traffic and waste collection. Moreover, they are expected to be able to affect the emissions from heating within their own facilities and through the role as land-use planner. It is therefore hypothesized that the effect will be found in these sectors:

H3: Lower levels of emissions related to municipal political parties will be within the sectors Heating, Waste and Sewage and Road Traffic.

3.3 Empirical findings on the effect of parties on climate change mitigation

To my knowledge, this is the first analysis of the effect of political parties on GHG emissions at the local level. However, some studies have examined political parties' influence on emissions and other environmental outcomes at the national level. I present some results from these studies in this sub-section.

The studies investigating the effect of Green parties on environmental outcomes are not very many. Jahn (2022) shows that green parties have an unambiguous diminishing effect on GHG emissions when participating in government. Jensen and Spoon (2011) find that pro-environment governments and Green parties reduce the difference between emissions and emission goals. Focusing on climate policies rather than emissions, Schulze (2021, 61) finds that Green Party representation in government has no effect on "hard" climate policies, and is associated with fewer "soft" climate policies. However, the finding is not very robust.

More studies look at the effect of left parties on environmental outcomes. Some studies find that leftist parties in government are associated with reductions in emissions. Garmann (2014) finds that the growth in CO2 emissions per unit GDP was lower under left-wing governments than under right-wing governments. Wang et al. (2022) use panel data covering 98 countries from 1990 to 2016, showing that left-wing governments are more likely to exhibit less CO^2 emissions than right-wing governments.

Other studies find that left-wing parties are associated with other positive environmental outcomes. Leftist parties have been shown to be associated with lower levels of air pollution. King and Borchardt (1994) find that left-party strength is associated with lower per-capita air pollution levels. Neumayer (2003) shows that combined traditional leftwing party strength in government is possibly correlated with lower air pollution levels. Aklin and Urpelainen (2013) show that the share of renewable energy in electricity generation increased when the government changed from right-wing to left-wing and decreased when it changed from left-wing to right-wing. Wen et al. (2016) show that leftwing governments had better environmental performances than other governments, except for Christian democratic governments. They utilize the Environmental Performance Index, which scores countries according to the degree of protection of human health from environmental harm and protection of ecosystems (Wen et al. 2016, 236). Schulze (2021) finds that left governments tend to introduce more climate policies than center and right governments.

The empirical findings do not only point towards a relationship between leftist parties and positive environmental outcomes. Lim and Duit (2018) find that left-wing governments are more likely to increase environmental policies in large welfare states while right-wing governments are more likely to increase environmental policies in small welfare states. Schulze (2014) finds that governments with an environmental inclination were more likely to ratify international environmental agreements, but did not find that government ideology on a left-right scale affected the propensity to ratify these agreements. In contrast to theoretical expectations, Tawiah (2022) finds that left governments have less stringent environmental policies by examining 23 OECD countries over 23 years.

4 Alternative or additional explanations

GHG emission levels are affected by a number of factors. The ambition of this thesis is not to identify all these factors. However, it is still important to consider some of these possible causes and control for them in order to get closer to discerning the effect of political parties. In this chapter, I present some alternative or additional factors that can affect the level of GHG emissions in the municipalities. These factors will also serve as control variables in the empirical analyses.

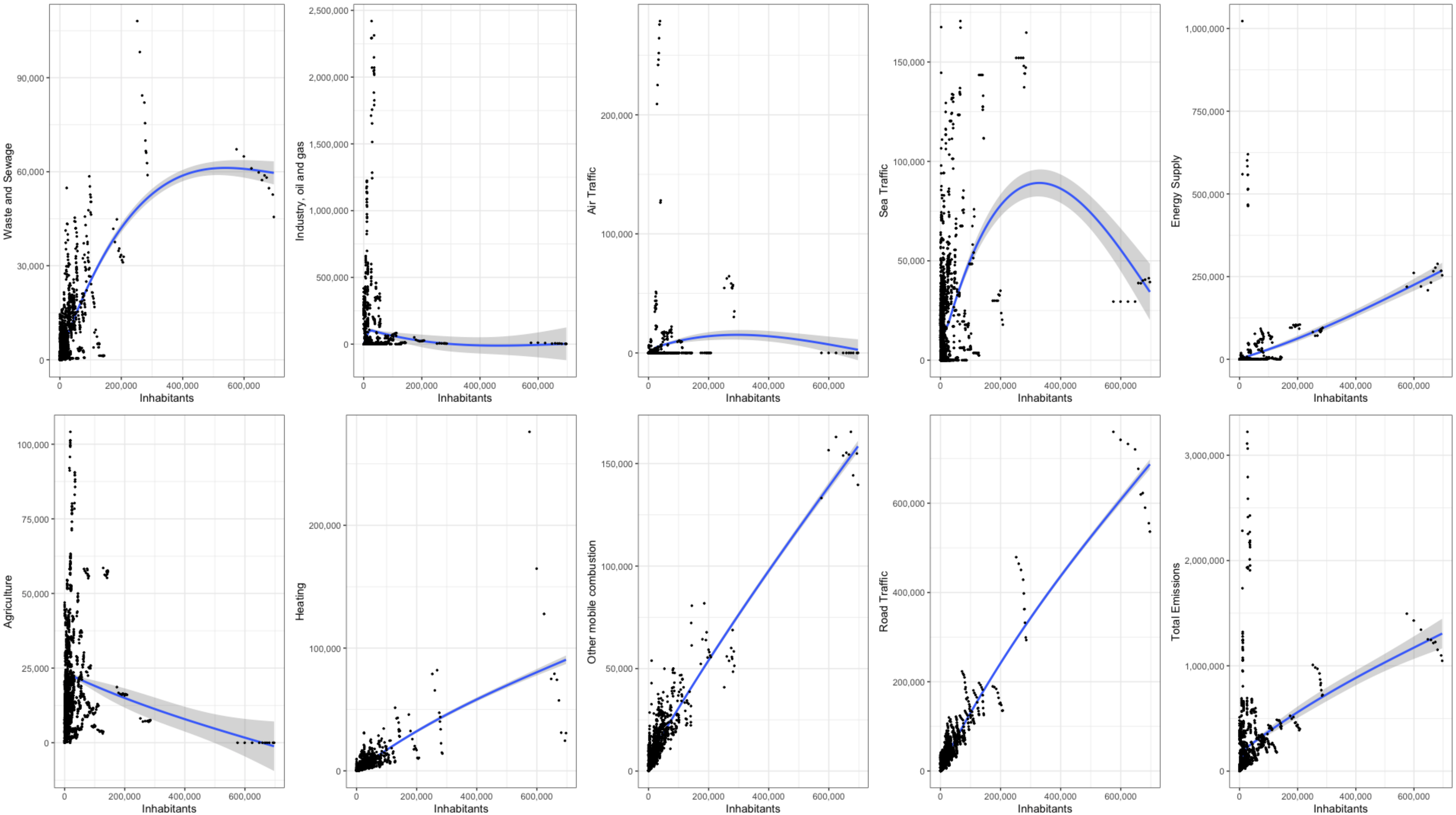
4.1 Population

It makes sense intuitively that the number of people in the municipality will affect the emissions from the municipality. The argument that increases in population put stress on the environment can be traced all the way back, at least, to Thomas Malthus (Rosa and Dietz 2012, 581). There are, however, some arguments for why the relationship between emissions and population may not be linear. For example, municipalities with a high population density may more efficiently use public transport and other infrastructures, reducing per capita emissions (Rosa and Dietz 2012, 582). Most evidence does, however, point in the direction of a strong relationship between population size and emissions. Jorgenson and Clark (2010) find that the population size of a country has a large and stable positive association with human-made CO_2 emissions. Martínez-Zarzoso, Bengochea-Morancho, and Morales-Lage (2007) investigate the impact of population size on CO_2 emissions in EU countries and find that the effect of population size on emissions differ between countries, but that population increases always are associated with increases in emissions.

Figure 4. 1 shows the relationship between the number of inhabitants in the municipality and the level of emissions from the different sectors. The plot in the bottom right corner shows the different sectors combined and, thus, the total amount of emissions. The total level of emissions seems to be positively correlated with population size. The relationship between the number of inhabitants and emissions from road traffic and other mobile combustion seems positive and

strong. There also seems to be a positive association between population size and energy supply and heating. Waste and sewage emissions also seem to correlate with population size, but the curve flattens at the top. When looking at the small dots that represent the different municipality-year observations, it is clear that the relationship between population size and emissions is by no means perfect. Moreover, some of the emission sectors do not seem to correlate with population size to a large extent. The population size can, therefore, not explain all of the difference in emission levels.

Figure 4.1 The relationship between population size and emissions from the different sectors



4.2 Economic activity

Economic activity and greenhouse gas emissions are deeply intertwined in modern society. Consumption conditions the stress a population puts on the environment. The level of consumption is, to a large extent, driven by affluence (Rosa and Dietz 2012, 581). Without significant de-carbonization, GDP determines CO_2 (Keen 2021, 1164). Green growth is widely assumed as a goal. Green growth is the idea that technological innovations lead to a decoupling of economic activity and GHG emissions. Empirical evidence on resource use and emissions does not show the existence of such a decoupling (Hickel and Kallis 2020).

Resource use is an integral part of economic activity, and resource use entails the use of fossil fuels, which is the primary driver of GHG emissions. In their study of Canadian provinces, Boyce and He (2022, 3) find that socioeconomics, meaning the scale and sectoral composition of the economy along with energy efficiency, was the number one factor affecting GHG emissions, with around 46 percent of the emissions being explained by this. The effect of political governance on emissions was only 0.7 percent (Boyce and He 2022, 1). This means that we can expect lower levels of economic activity in a municipality to lead to lower levels of emissions. Economic activity is, therefore, a crucial factor to consider when looking at GHG emissions.

4.3 Industry

Not all economic activity leads to the same amount of GHG emissions. Moreover, not all emissions related to consumption happens where the consumer is. If municipality A produces something municipality B consumes, municipality A will have emissions related to municipality B's consumption included in their calculations. Whether a municipality has a heavily polluting industry or not will affect the total level of GHG emissions. The closure of large industries can also explain drastic reductions in emissions. Ouyang and Lin (2015) investigate CO_2 emissions from the industrial sector in China. They find that while energy intensity, energy mix, and carbon intensity can dampen the polluting effect of industry, industrial activity is the main factor driving increases in industrial CO_2 emissions. This indicates that although there are ways to cut emissions in the industries, industrial activity is still likely to lead to higher emission levels.

4.4 Gender

Research has shown that gender is a strong individual-level determinant for concern about climate change, and men seem to be less concerned than women (Poortinga et al. 2019; Hornsey et al. 2016; Imbulana Arachchi and Managi 2021). Female political representatives might therefore be more concerned about climate change than men. It has also been theorized and shown empirically that the descriptive representation of women, i.e., female political representatives, leads to the substantial representation of women's preferences (Lowande, Ritchie, and Lauterbach 2019; Jones 2014, 175; Mansbridge 2005, 622). Based on the idea that female representatives will seek to substantially represent the female population and therefore be more in favor of pro-environmental policies, more female representatives is expected to lead to lower levels of GHG emissions (Salamon 2023, 175).

There are several empirical findings on the relationship between female representatives and positive environmental outcomes. Salamon (2023) finds a positive relationship between women's representation and renewable energy consumption in high-income and middle-income states. Ramstetter and Habersack (2020) find that women in the European parliament are more likely to support pro-environmental legislation. Sundström and McCright (2014) show that Swedish women show greater environmental concern, both in the general public and in municipal and county councils. A study comprising 91 countries finds that having more women in parliament correlates with a larger number of climate change mitigation policies (Mavisakalyan and Tarverdi 2019). Women are more concerned about climate change at the citizen level, and female representatives are expected to represent women substantially. The share of women in the municipal council is expected to have a decreasing effect on GHG emissions in that municipality.

5 Data

This chapter presents the data used in the statistical analysis. I begin by discussing the structure of the data. Then I discuss the measurement and calculation of the emission variable, which will serve as the dependent variable in the analysis. The dependent variable is an aggregate measure of nine different emission sectors, and I also present the content of these sectors. The chapter also includes descriptions of the operationalizations of the independent and control variables, along with moment and rank statistics for all variables.

The data I use has a Time-Series-Cross-Sectional (TSCS) structure and covers all Norwegian municipalities over 13 years, from 2009 to 2021. The data is limited to these years due to limitations in data on emissions at the municipal level before this. From 2017 to 2020, several Norwegian municipalities were part of municipal mergers. For an overview of the municipalities included in the mergers and their old and new names, see Table 5.1. The data on GHG emissions in Norway is measured according to 2020 borders, and it was impossible to get emissions data according to the pre-2020 borders.[1] Fortunately, it was also possible to retrieve all the control variables according to the new borders.

The new municipalities Hamarøy, Heim, Hitra, Orkland, and Narvik include old municipalities that are split between several new municipalities. For example, both Heim, Hitra, and Orkland contain parts of a previous municipality named Snillfjord. The new municipalities that include split municipalities are removed from the dataset as it is impossible to calculate the emissions back in time for these. The dataset includes 351 out of 356 municipalities over ten different time points. This leaves us with 3510 municipality-year units.

To include the merged municipalities in this way has some implications. In a way, I include the merged municipalities as if already merged in 2009. This entails treating what was several different municipalities in reality as one municipality in the dataset. For example, Fjord is a new municipality created by a merging the old municipalities Norddal and Stordal. Norddal

[1] I contacted Miljødirektoratet to see if the data was available according to the old borders, but they replied that it was not.

had 21 MC representatives, and Stordal had 15 MC representatives before the mergers. In the data, they are treated as a large municipal council of 36 members all the way back. Of course, the representatives in Stordal could not affect the emissions in Norddal and vice versa before they were merged. The idea is that representatives from both municipalities could affect the total amount of emissions by affecting the emissions in their municipality. The effect of politicians in one municipality might, however, be lost when the municipalities are artificially merged in this way. Suppose that a municipality that has increased emissions is merged with a municipality that has decreased emissions. In that case, it might seem like the politicians have not been able to affect the emissions when they actually have. This solution is not perfect, but it is the best solution the data allows. It is problematic because it assumes political units that did not actually exist. It is workable because it entails coupling dependent, independent, and control variables covering the same geographical areas. The analyses are also run without the municipalities included in mergers as a robustness test.

Table 5.1 Overview over municipalities included in mergers

New municipality	**Old municipalities**	**New municipality**	**Old municipalities**
Aurskog-Høland	Aurskog-Høland and Rømskog	**Namsos**	Namdalseid, Namsos and Fosnes
Alver	Radøy, Lindås and Meland	**Narvik**	Narvik, Ballangen and Tysfjord (split)
Bjørnafjorden	Fusa and Os	**Nordre Follo**	Oppegård and Ski
Drammen	Drammen, Nedre Eiker and Svelvik	**Nærøysund**	Vikna and Nærøy
Fjord	Norddal and Stordal	**Orkland**	Orkdal, Agdenes, Snillfjord (split) and Meldal
Færder	Tjøme and Nøtterøy	**Sandefjord**	Sandefjord, Andebu and Stokke
Hamarøy	Hamarøy and Tysfjord (split)	**Sandnes**	Forsand and Sandnes
Hammerfest	Hammerfest and Kvalsund	**Senja**	Berg, Lenvik, Torsken and Tranøy
Heim	Hemne, Halsa and Snillfjord (split)	**Sogndal**	Balestrand, Leikanger og Sogndal
Hitra	Hitra and Snillfjord (split)	**Stad**	Eid and Selje
Holmestrand	Sande and Holmestrand	**Stavanger**	Finnøy, Rennesøy and Stavanger
Hustadvika	Eide and Fræna	**Steinkjer**	Steinkjer and Verran
Indre Fosen	Rissa and Leksvik	**Sunnfjord**	Førde, Naustdal, Gaular and Jølster
Indre Østfold	Askim, Eidsberg, Hobøl, Spydeberg and Trøgstad	**Tjeldsund**	Skånland and Tjeldsund
Kinn	Flora and Vågsøy	**Trondheim**	Klæbu and Trondheim
Kristiansand	Kristiansand, Songdalen and Søgne	**Tønsberg**	Re and Tønsberg
Larvik	Larvik and Lardal	**Ullensvang**	Jondal, Odda and Ullensvang
Lillestrøm	Skedsmo, Fet and Sørum	**Volda**	Hornindal and Volda
Lindesnes	Lindesnes, Mandal, Marnardal	**Voss**	Granvin and Voss
Lyngdal	Audnedal and Lyngdal	**Ørland**	Bjugn and Ørland
Midt-Telemark	Bø and Sauherad	**Øygarden**	Fjell, Sund and Øygarden
Molde	Midsund, Molde and Nesset	**Åfjord**	Roan and Åfjord
Moss	Moss and Rygge	**Ålesund**	Ålesund, Haram, Sandøy, Skodje and Ørskog

Source: *Regjeringen.no*

5.1 Dependent variable

The dependent variable is a continuous scale of the GHG emissions from each Norwegian municipality retrieved from Miljødirektoratet (The Norwegian Directorate for the Environment). It is measured bi-annually from 2009 to 2015 and annually from 2016 to 2021, leaving us with ten time points. The GHGs included are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), measured in CO_2 equivalents. These three gases covered 97 percent of the GHG emissions at the national level in 2017 (Miljødirektoratet 2022a, 10). The calculations follow the UN's climate panel (IPCC) standard. Included are direct emissions stemming from within the municipality. This means that the data exclude emissions caused by the municipality and its inhabitants through their consumption if they happen outside the municipality's border. Therefore, the numbers presented in the data do not give the full picture of a municipality's ecological footprint. Municipalities may decrease or increase their *actual* emissions without the data capturing this. For example, if, hypothetically, all the inhabitants in a municipality bought new electric cars, the emissions would plummet since there would be virtually no emissions from road traffic. What would not show in the data is the emissions (and other adverse effects) from the production of these cars, which would probably happen in another country.

Miljødirektoratet does the measurements in three ways. The first is self-reporting from businesses. Certain sectors have mandatory reporting, and these reported emissions enter the emission accounts of the municipality where the business is situated. The second measurement method, which is the one most used, is data on activity and the emissions these activities are known to make. Data on activity in the municipality, such as liters of diesel bought or the number of livestock, is multiplied by an emission factor (Miljødirektoratet 2022a, 5). The emission factor is the amount of emissions connected to an activity based on research and experience (Miljødirektoratet 2022a, 8). Equation 5.1 illustrates how emissions from activity data are measured.

Equation 5.1

$$Emissions = \Sigma\ Activity\ data\ x\ Emission\ Factor$$

When the other two methods are impossible, so-called “distribution keys” estimate the emissions from the municipalities. Miljødirektoratet uses this method when data on where the emissions actually happen is missing. The distribution keys signify the allocation of national numbers on emissions and activity data. National emissions or activity data are distributed between the municipalities based on relevant statistics indicating where the emissions are happening. This can either be information that directly leads to emissions or so-called surrogacy data, which indicates the size of emissions (Miljødirektoratet 2022a, 9).

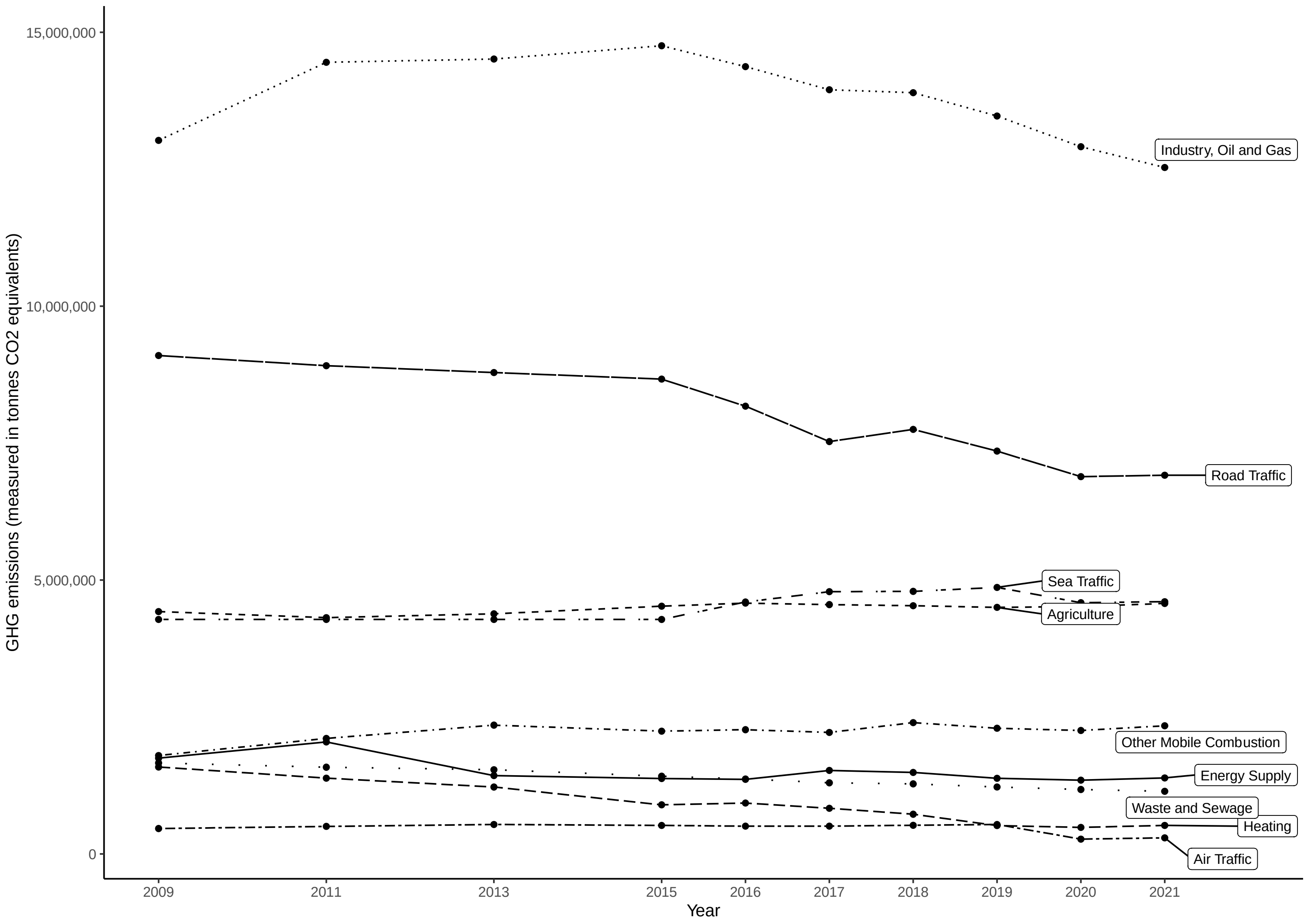
The data on GHG emissions is an aggregate of nine different sectors. Table 5.2 shows these sectors, what they include, and the main calculation method used to gather data in each sector. Figure 5.1 shows the development in emissions over time within each sector for all municipalities gathered.

Table 5.2 The different emission sectors

Sector	Explanation	Main calculation method
Road Traffic	All traffic registered vehicles.	Activity data
Industry, oil and gas	Oil and gas extraction, industry and mining. (Offshore excluded).	Reporting.
Energy supply	Incineration, district heating, electricity production and other energy supplies.	Reporting.
Heating	Heating of commercial buildings and households	Activity data.
Other mobile combustion	Use of fuel for non-road motor driven objects, such as tools, tractors, snowmobiles and construction machines.	Distribution keys.
Sea traffic	Domestic, foreign and transit traffic in Norwegian municipalities.	Activity data.
Air traffic	The landing and take-off phase for airplanes and helicopters on Norwegian airports.	Activity data.
Waste and sewage	Landfill gas, biological treatment of waste, waste and sewage.	Activity data.
Farming	Digestive processes for animals, manure management, agricultural areas.	Distribution keys.

All information is from (Miljødirektoratet 2022a).

Figure 5.1 The development of emissions from the different sectors



A measurement is reliable if it is consistent, meaning that measuring identical cases will give identical results. It is valid if it accurately measures the concept it is supposed to measure (Kellstedt and Whitten 2018, 112-114). The measurement method for the dependent variable is reliable in the sense that it is identical over time and between units. It is also a reasonably valid measure, as it measures the three dominant GHGs to imply something about GHG emissions from the municipalities. However, the data on emissions can contain inaccuracies due to incorrect reporting or inaccurate calculations, which affects the reliability. In the data based on activity, local political measures affecting the activity level can be expected to show in the data. This is not necessarily the case if the data is constructed using distribution keys. In this case, the data might not measure what is actually happening as it is measured less directly, affecting the validity. However, as the measurement method is constant over time and between units, the data can still be considered comparable, assuming mistakes and inaccuracies have approximately the same probability of happening in any unit at any time.

Measuring actual emissions rather than, for example, climate policies provides several advantages. It is a way to measure performance and effectiveness rather than symbolic actions. Böhmelt, Böker, and Ward (2016) find that democratic inclusiveness is positively associated with climate policy outputs but probably not with lower emissions of GHG gases. This indicates that not all climate change mitigation policies will have an effect on emissions. Since mitigating climate change is dependent on GHG emissions reductions, measuring emissions rather than policies seems reasonable. Garmann (2014) argues that measuring actual emissions is good because we measure what actually matters and because it is more easily comparable than policies.

Using GHG emissions as a dependent variable entails treating the distance between the party representation and emission levels as a “black box”. The model does not explain what happens between the moment the politicians are elected and the time emissions are measured. The theoretical assumption is that there is a causal chain between the politicians and the changes in emissions. Using emissions rather than the adoption of climate change mitigation policies as a dependent variable means that the causal chain becomes longer, and the interpretation of the results involves more assumptions. It is easier to claim that politicians can affect policies, than an actual political outcome. Using a political outcome as a dependent variable makes causal inferences more difficult. On the other hand, this dependent variable avoids an assumption that is necessary if climate policies are used as a conceptualization of climate change mitigation performance. Namely that the policies actually reduce emissions. While using climate change mitigation policies as dependent variable could facilitate causal inference, emissions are a better conceptualization of climate change mitigation performance.

Researchers include data on emissions in statistical analyses in different ways. The first and most straightforward way is the total level of emissions. Several TSCS studies investigating the effect of political factors on GHG emissions use the total level of emissions as the dependent variable (Povitkina 2018; Wang et al. 2022). However, countries and municipalities differ greatly in population size. Because of this, some studies use emissions per capita as the dependent variable (Rahman and Alam 2021; Jahn 2022). However, emissions are not necessarily related to population size. As Figure 4.1 illustrated, some but not all of the different emissions sectors seemed to be strongly correlated with the number of inhabitants. Emissions is therefore used as the dependent variable, while population size is instead used as a control variable. I use both the total amount of emissions and the different emission sectors as dependent variables in different analyses. Descriptive statistics for the total amount of emissions and the different sectors are shown Table 5.3.

Table 5.3 Descriptive statistics for the dependent variables

Measurement	Total emissions	Road Traffic	Waste and Sewage	Air Traffic	Energy supply	Agriculture	Heating	Industry, oil and gas	Other mobile combustion	Sea Traffic
Observations	3510	3510	3510	3510	3510	3510	3510	3510	3510	3510
Min.	1184	0.9	3.5	0	0	0	12.13	0	39.55	0
Max.	3222220	759920.6	108070	278729	1022519	104138	276099.60	2419646	165488.56	170593
First quartile	21032	4707.8	333.2	0	0	4249	397.99	0	1409.97	0
Median	41828	10304.5	904.7	0	0	8696	866.84	0	3109.74	1843
Third quartile	85230	23314.1	3227.1	0	0	15896	2111.51	1816	6896.78	17380
Mean	104781	22494.7	3844	1309	4238	12611	2554.64	38732	6254.90	12742
Std. dev.	232105.8	47682.88	8333.285	12944.92	37401.17	13314.49	7807.864	180805.7	11206.44	22706.42
Variance	53873117707	2273656593	69443637	167570971	1398847283	177275750	60962738	32690707043	125584396	515581442
Skewness	6.926	8.77715	4.831666	17.03253	15.28034	2.613663	18.0438	8.167917	7.577825	3.176226
Kurtosis	68.816	108.1048	35.08052	323.163	288.3262	12.60465	511.5918	83.10658	88.18939	15.76977

5.2 Independent and control variables

The independent variable is party representatives for each party within the executive committee (EC) of the municipal council, measured as a percentage of the seats. Measuring the percentage seat share makes municipalities with very differently sized municipal councils comparable. Jahn (2022) uses the percentage of ministerial positions for a specific party family when analyzing the effect of party families on emissions at the national level. Although the systems are not identical, the executive committee is comparable to a national government. The municipal council representatives are elected every fourth year. The elections included here are from 2007, 2011, 2015, and 2019. I assume that they keep the seat for the entire period or that if they quit, someone from their own party replace them.[2] The municipal elections are held in September, and the first meeting of the new council is in October. Table 5.4 shows descriptive statistics for each of the independent variables.

In order to test H1a, the percentage seat share of Green Party representatives in the executive committee of the municipal council is the variable of interest. The descriptive statistics in Table 5.4 show that most municipality-year observations do not have any Green Party representatives in the municipal councils, as the median of this variable is zero. In Norway, there are three parties on the left: the Red Party (Rødt), the Socialist Left Party (SV) and the Labor Party (Ap) (Fiva, Folke, and Sørensen 2018, 12). To test H2a, the independent variable named leftist parties is the combined seat share of these three political parties. Some executive committees are entirely leftist, and the median and mean are around 30 percent. To test H2c, I use the independent variables measuring the seat share of the three leftist parties separately. The Labor Party has been the largest political party in this time period. They have had over 80 percent of the seats in the EC, and the median for the country-year observations is 25 percent. The Socialist Left Party has had above a 70 percent seat share, but the mean is just under 5 percent and the median is at zero. The Red Party is a small party and has at most had 30 percent of the seats in an EC, while the mean is only 0.42 percent.

[2] This is a reasonable assumption since the executive committee is proportional of the municipal council, and the municipal council does not change during the election period. In Oslo and Bergen where they employ a parliamentary system, the composition of the executive committees can change. Bergen changed the composition of the executive committee in December 2021. The new composition is not included in the dataset as the dataset ends in 2021.

Table 5.4 Descriptive statistics and operationalization of independent and control variables

Variable	Operationalization	Obs.	Mean	Median	Std. dev.	Min	Max
Green Party (MDG)	Share (%) of Green Party representatives in executive committee (EC).	5340	0.785	0	3.354	0	50
Labor Party (Ap)	Share (%) of Labor Party (Arbeiderpartiet) representatives in the EC.	5340	22.47	25	14.335	0	85.71
Socialist Left Party (SV)	Share (%) of Socialist Left (SV) representatives in the EC	5340	4.71	0	8.550	0	71.40
Red Party (Rødt)	Share (%) of Red Party (Rødt) representatives in the EC .	5340	0.42	0	2.447	0	33.30
Leftist Parties	Share (%) of Labor Party, Socialist Left Party and Red Party representatives combined in the EC.	5340	32.6	30	16.187	0	100
Centre Party (Sp)	Share (%) of Centre Party (Senterpartiet) representatives in the EC.	5340	19	16	15.013	0	80
Progress Party (Frp)	Share (%) of Progress Party (Fremskrittspartiet) representatives in the EC.	5340	9.83	7.69	11.740	0	57.10
Conservative Party (Høyre)	Share (%) of Conservative Party (Høyre) representatives in the EC.	5340	16.8	14.3	13.448	0	80
Christian Party (KrF)	Share (%) of Christian Party (Kristelig Folkeparti) representatives in the EC.	5340	6.92	0	9.492	0	55.6
Liberal Party (Venstre)	Share (%) of Liberal Party (Venstre) representatives in the EC.	5340	5.25	0	8.487	0	66.7
Female representatives	Share (%) of female representatives in the EC.	5340	38.407	38.095	8.352347	4.762	68.421
Inhabitants	Number of inhabitants in municipality as of January 1st.	4573	14467	5021	41601.43	192	697010
Economic activity	Number of people employed within the municipality.	4573	7358	2046	27940.25	88	507232
Industry	Share (%) of people employed that are employed within industry.	4419	10.974	9.304	8.044	0	48.872
MDG vote share	Share (%) of votes given to the Green Party.	5340	1.070	0	2.202	0	23.164

Note: *All data is retrieved from Statistics Norway (SSB).*

The different executive committees will include different combinations of parties. Different coalitions will probably be made based on political orientation, but maybe also based on other characteristics. To measure only the seat share the different parties have will not capture all the dynamics that are happening in the executive committee. Local municipality-specific political lists also play a role in Norwegian local politics. They hold, on average, 8.8 percent of the seat share in the executive committees. Some executive committees consist of only local lists.

The theoretical reasons for choosing the control variables are explained in Chapter 4. All variables are retrieved from Statistics Norway (SSB). I control for female representatives in the municipal council[3], the number of inhabitants, economic activity, and the share of employed working in the industry. Descriptive statistics for the control variables are displayed together with the independent variables in Table 5.4.

I use the number of people employed within the municipality as a proxy for economic activity. This means that people are counted within the municipality in which they work and not in which they live. If a person commutes to a neighboring municipality, this person will be counted within the municipality where they work. The variable is measured as “persons performing income generating work with at least one hour duration, including persons on temporary leave, persons performing military service or persons on employment arrangements when the wage is provided by the employer”. This is according to the recommendations from the International Labor Union (ILO) (SSB 2023). It does not exist, to my knowledge, a measure that measures economic growth similar to the GDP at the municipal level in Norway. Measuring the number of people employed within the municipality will, however, say something about the economic activity as it indicates where activity is happening.

[3] I control for the percentage share of female representatives in the municipal council rather than in the executive committee because of data availability.

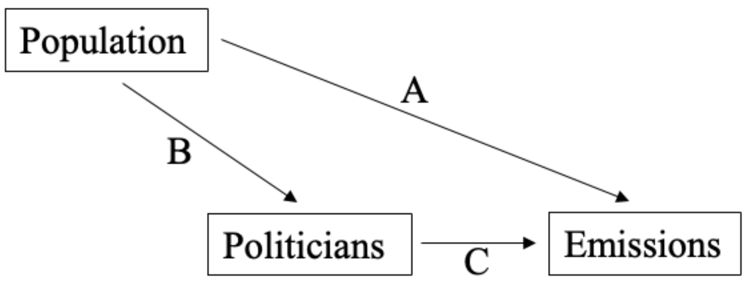
6 Methodological approach

In this chapter, I present and discuss the methodological strategy employed. Chapter 7 presents the results of the analyses. Comparing local political units makes it easier to construct controlled comparisons, as the local units are nested within the same higher-level unit (Snyder 2001, 95). I perform panel regression and the relatively new method called panel matching developed by Imai et al. (2021). These methods contribute to answering my research question in different ways and, I argue, make the analysis as a whole more robust. Regression analysis is the standard for quantitative analysis in the social sciences, and allows for using a continuous independent variable. I begin the chapter by discussing why the inclusion of panel matching is useful in this thesis.

Panel matching gives stronger indications of causality and is less dependent on model specifications than traditional regression analysis (Imai et al. 2021). The research question is concerned with causality, as it asks whether political parties at the local level can *affect* greenhouse gas emissions. We cannot observe causality. Moreover, in this analysis, I treat everything that happens from the moment the politicians are elected to the possible change in levels of emissions as a black box, which means that I do not try to uncover the process of *how* the political parties reduce emissions. This would be interesting to know, but it is beyond the scope of this thesis. The distance between my independent and dependent variables is, figuratively speaking, quite long, and the processes between this alleged cause and effect is not taken into consideration. Panel matching allows me to look at municipalities that are as similar as possible but either have or do not have the political party of interest in the executive committee and compare the difference in emissions levels in these municipalities. By doing this, we can, with a larger degree of certainty, make causal inferences about the effect of political parties on emissions. More specifically, this method allows me to, to a larger extent, discern the effect of society and politicians on emissions.

When conducting studies on the effect of politicians on an outcome, one major issue is to separate the effect of the politicians and the population. The people elect politicians. The lower emissions levels observed when Green or leftist politicians are present may be due to having an environmentally concerned population that (1) reduces individual level emissions and (2) votes for these parties. This would mean that it is not the politicians that cause the emissions reduction, but "green" individuals cause both the representatives and emissions reduction. Figure 6.1 illustrates this relationship. The research question of this thesis is concerned with the effect of political parties on GHG emissions, illustrated by arrow C in the figure. However, the municipality's population can affect emissions both by electing politicians (arrow B) and by individual lifestyle choices (arrow A). Environmentally concerned individuals will probably both elect politicians from a party they expect will reduce emissions while they also try to reduce emissions in their everyday life. It is difficult to say whether the observed changes in emission levels are due to individual-level measures (arrow A) or political decisions (arrow C).

Figure 6.1 Illustration of the relationship between population, politicians and emissions



To my knowledge, there does not exist survey data that is representative at the municipal level for all municipalities in which respondents are asked about environmental attitudes. The closest we can get to know the attitudes at the population level is the vote shares for the different parties. One important advantage of including a matching method is that it makes it possible to match units that do and do not have a specific party in the executive committee but that have approximately the same share of votes for that party. When performing regression analysis, controlling for vote share might mean controlling away the actual effect because these are so highly correlated. Of course, to completely discern the effect of the population and the politicians elected by the population is close to impossible. However, by matching municipalities with approximately the same percentage voting for a specific party, one can, in some sense, control for this effect. This follows the same logic as close elections regression discontinuity designs, where units with similar voting results but where there is a minimal majority for either left or right are compared (Snowberg, Wolfers, and Zitzewitz 2007; De la Cuesta and Imai 2016). By keeping voter preferences close to constant, the effect of politicians can be argued to be found.

6.1 Regression analysis

I perform a panel regression using an Ordinary Least Squares (OLS) linear model. Using time-series cross-sectional data provides several advantages for statistical analysis. Comparing across both time and units reveals dynamics that are difficult to discover by only looking at one time point or unit. When using panel data, fixed or random effects can be employed to control for unobserved heterogeneity (Dougherty 2011, 514-515).

6.1.1 Fixed versus random effects

We can expect variation in emissions levels between municipalities, caused by municipality-specific characteristics, that the independent and control variables cannot explain. Firstly, it is a reasonable expectation that there are large differences between units in the level of GHG emissions, and that a municipality that emits a lot one year is expected to do so the other years. Moreover, some years can also be expected to affect emission levels. For example, the years affected by covid19 (2020 and 2021) may display different patterns than other years. Having these group-based dependences can lead to poorly fitted models and misleading estimates of the effect of the independent variable (Clark and Linzer 2015, 390).

The two main approaches to handling these issues and fit models using TSCS data are fixed effects (FE) regressions and random effects (RE) regressions (Dougherty 2011, 518). By employing unit fixed effects, one controls for all unit-specific variance by including all units as dummy variables. FE models are often considered the gold standard in econometric methods, but the use of fixed effects as the default standard has been questioned (Plümper and Troeger 2019). By controlling out context, FE models may miss out on too much of what is actually of interest to the researcher (Bell and Jones 2015, 134). Most of the variance in emission levels is between rather than within the municipalities. This means that using a FE model entails losing a lot of the variation. Moreover, the common fixed effects estimator can be biased in a TSCS model with few time points (Garmann 2014, 5).

When using a RE model, one assumes that the factors that can affect the dependent variable but are not included in the model can be appropriately summarized by a random error term (Verbeek 2017, 390). Beck and Katz (2007) show that with TSCS data, RE models perform well, even when the normality assumptions are violated (Bell and Jones 2015, 136). Bell and Jones (2015, 136) argue that RE models are preferred to "complete pooling" methods, which assume no differences between higher-level entities and FE, which do not allow for the estimation of higher-level, time-invariant parameters or residuals.

There are advantages and disadvantages with both FE and RE models, and there seem to be disagreements in the scholarly community on when the different models are appropriate. RE models can be biased, but they reduce the variance of the estimates of the coefficients. FE will be unbiased but may be subject to high sample dependence (Clark and Linzer 2015, 399). The data structure does indicate that FE might entail losing a lot of the information, as most of the variation is between units. However, as I have a sample of almost all the municipalities, sample dependence is not that big an issue. However, if one seeks to make inferences beyond the sample, geographically or in time, the sample dependence introduced with a FE model is problematic. However, the research question seeks to explain how politicians have been able to affect emissions *within* their municipality, and FE might seem like the model that measures this most accurately, as it controls for *all* unit-level variation. To robustly test my hypotheses, I include models with both random and fixed effects on the units.

As mentioned, there can also be time-specific dependencies in addition to unit-specific dependencies. As Figure 5.1 shows, it is in the last part of the time series where we can see signs of reductions in emissions. These are also the years affected by the covid-19 pandemic. The Green Party has also become more successful in recent years. Without model specifications, it might be that a higher number of Green Party representatives is correlated with lower levels of emissions because both occur at the later end of the dataset. In order to control for this, I also run models with so-called two-way random and two-way fixed effects, where random or fixed effects is used both on time and units. Although criticized, the two-way fixed effects model has become the default method for estimating causal effects from panel data (Imai and Kim 2021).

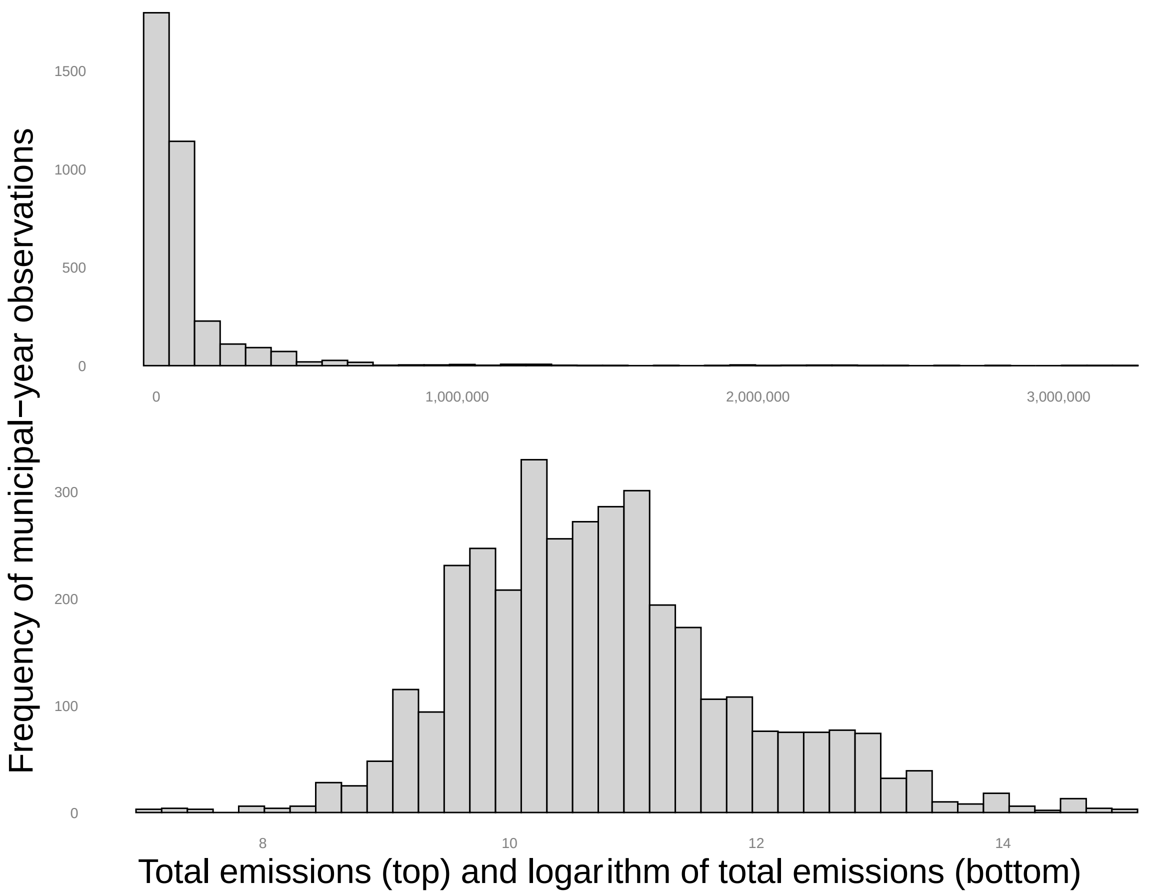
6.1.2 Time lags

The effect of party representatives on GHG emissions will likely take some time. After elections, it takes time before politicians form, decide upon, and implement policies and possibly even more time before these policies affect actual emissions. Garmann (2014, 7) introduces a model with one and two years lags to test political factors on emissions. Jahn (2022, 479) shows that the effect of governments on emissions is not instant but often needs two years to show substantial impacts. He uses a newly established technique of optimized delays (Jahn 2022, 487). I have therefore included models with both a one-year and a two-year lag of the seat shares for the political parties and the female representatives. The effect of the other variables is assumed to act more immediately.

6.1.3 Dependent variable distribution

An assumption for performing regression analysis is that the prediction error, meaning the deviation between the model predictions and reality, is normally distributed. This is facilitated by a normally distributed dependent variable. The normal distribution is symmetrical, meaning that the mode, median and mean are the same, and has a predictable area under the curve based on how many standard deviations away from the mean one measures (Kellstedt and Whitten 2018, 149). In order to test the distribution of the dependent variable I performed the Shapiro-Wilk test (Shapiro and Wilk 1965). The test showed that the distribution of the dependent variable deviated significantly from a normal distribution ($W = 0.365$, p-value < 0.001). The positive skewness measures show that the distribution is right skewed. This indicates that there are some exceptionally high outliers. Figure 6.2 shows the distribution of the dependent variable across the municipality-year observations. The top histogram shows the distribution of the data as it is in reality, and this confirms graphically the results of the Shapiro Wilk test. The natural logarithmic transformation is used on the dependent variable in order to make it closer to normally distributed. This transformation is used to correct the skewness of variables that have a small number of cases with extremely high or extremely low values (Imai 2017, 92). The distribution of the log-transformed dependent variable is shown in the bottom graph of Figure 6.2. It is clear that the log-transformed data is much closer to normally distributed than the un-transformed data. (Povitkina 2018, 417) also log-transforms her data on GHG emissions due to positive skewness.

Figure 6.2 Distribution of the main dependent variable (un-transformed and transformed)



In order to test H3 concerning which sectors the political parties are able to affect, I also run models with the different emissions sectors as dependent variables. The distributions of these variables are also very skewed, and they have therefore also been log-transformed. Some sectors included many zero-values. An example is the sector Sea Traffic, as municipalities without a coast line obviously do not have any emissions from sea traffic. When this was the case, a small constant was added to the variable, so that all values were above zero, before the log-transformation. The distribution of the sector emissions variables before and after log-transformation can be found in Appendix A.

6.2 Panel matching

Panel matching employs matching and difference-in-difference estimators on TSCS data (Imai et al. 2021). This type of method imitates an experiment. The basic design of an experiment is that identical units receive or do not receive a treatment. Everything else is kept constant, and one can conclude that any observed difference is due to the specific treatment. In the social sciences, pure experiments are difficult to perform for practical and ethical reasons. However, the experimental design can be imitated by conceptualizing the independent variable as a treatment, finding the most similar units possible except for whether they have received the treatment, and then comparing the differences between these. Compared to other experiment-imitating-approaches such as synthetic control methods (Abadie, Diamond, and Hainmueller 2015), panel matching does (1) not require a long time pre-treatment period, (2) allow multiple units to be treated at different time points, and (3) allow units to switch their treatment status (Imai et al. 2021, 2). Since the data (1) covers a relatively short time period, (2) the treatment of having specific party representatives can be reversed, and (3) several municipalities have the specific party representatives at different times, panel matching is ideal.

Before starting the analysis, the researcher must decide a lead, lag, treatment, and a causal quantity of interest. The lag indicates how many years back in time the units are matched upon. I choose L=8, which means matched units have identical treatment histories at least eight years back in time, as this equals two election periods. This implies the assumption that political measures done more than two election periods ago do not significantly affect present reductions in emissions. The lead (F) indicates the period after the treatment we want to measure the effect. Because of the limited time span, the maximum possible F is 0:2. This means that we measure the instantaneous effect of the treatment (F=0), the effect one year after (F=1), and the effect two years after (F=2). This is also in accordance with the regression analysis and the literature on the effects of politics on emissions, which assumes that we will be able to see effects two years after (Jahn 2022; Garmann 2014). The choice of lead should be motivated by the research interest, while the choice of lag is subject to a bias-variance tradeoff (Imai et al. 2021, 7). The treatment is having or not having the presence or a majority of a specific party in the municipal council's EC. The causal quantity of interest is the average treatment effect of the treated

(ATT). Considering the research question, this is an appropriate measure as this will show the average change in levels of emissions caused by political representatives.

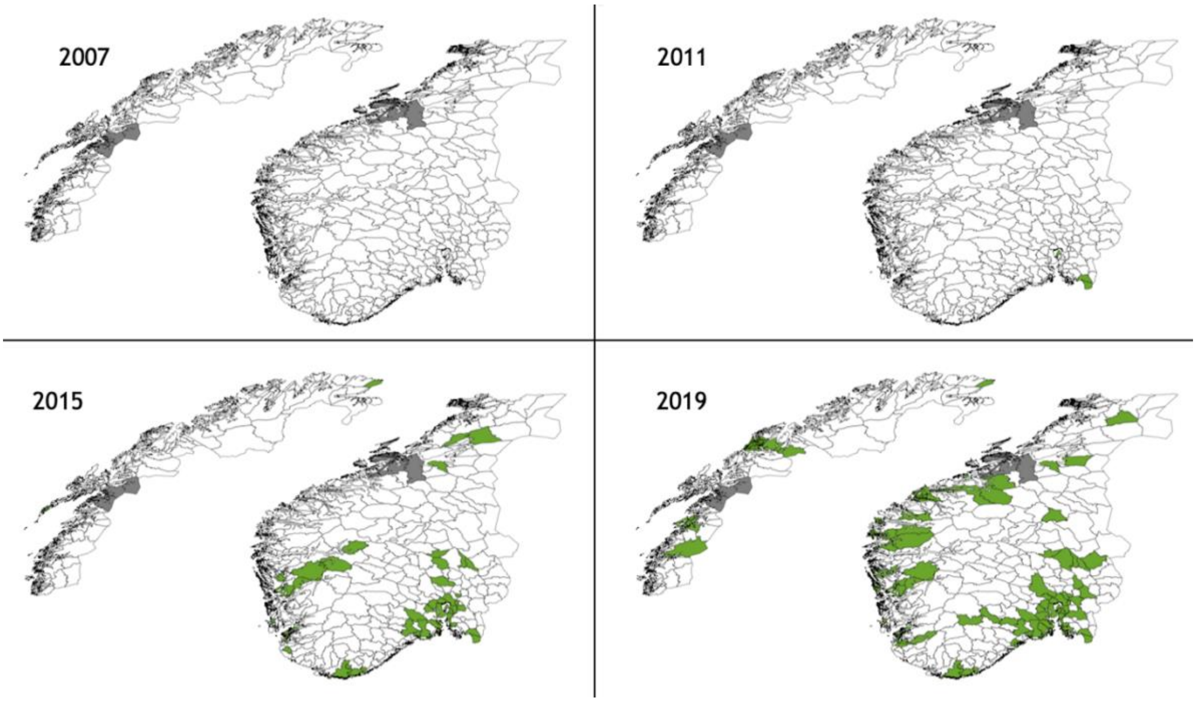
The first step is to create matched sets based on treatment history only. I perform panel matching with five different treatments in order to test the hypotheses. Table 6.1 shows the different treatments. When testing the effect of the Green, Red, and Socialist Left Party, the treatment is party *presence* in the executive committee. As the Labor Party is a much larger party, which has a majority in several ECs, this treatment is a party *majority*. A majority-measure makes sense from a theoretical point of view, as a majority is likely to get their policies implemented. Also, as the Labor Party is present in many ECs, using their presence as treatment did not allow enough untreated units to compare with. The leftist party treatment is also a majority-measure.

Table 6.1 The different treatments for panel matching

Treatments
(1) Green Party presence in the EC (Green Party representatives > 0).
(2) Leftist party majority in the EC (Leftist party seat share > 50%).
(3) Red Party presence in the EC (Red Party representatives > 0) .
(4) Socialist Left Party presence in the EC (Socialist Left Party > 0).
(5) Labor Party majority in the EC (Labor Party seat share > 50%).

In order to make the comparison more accurate, the matched sets are then refined based on covariates. There are several refinements methods. When choosing a calculation method to refine the sets one should consider the covariate balance, meaning the difference between the treated and the untreated units when it comes to the covariates (Kim et al. 2022, 19). I will now present the treatment distribution and the covariate balance for each of the different treatments. In the descriptions below I have only included a plot over the covariate balance without treatment and with the refinement method that provided the best covariate balance. Covariate plots for different refinement methods for the different treatments are in Appendix C. The closer the lines are to zero, the more similar are the treated and untreated units.

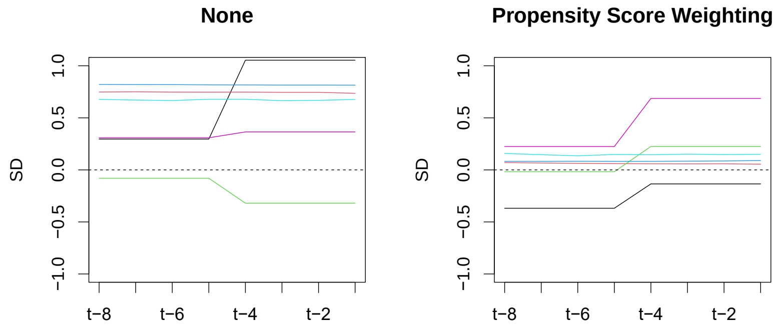
Figure 6.3 Municipalities with Green Party representatives in the EC



Note: The figure shows an overview of treatment = municipalities with Green Party presence in EC (2007-2021) for 351 out 356 Norwegian municipalities (2020 borders). Data source: (Miljødirektoratet 2022b).

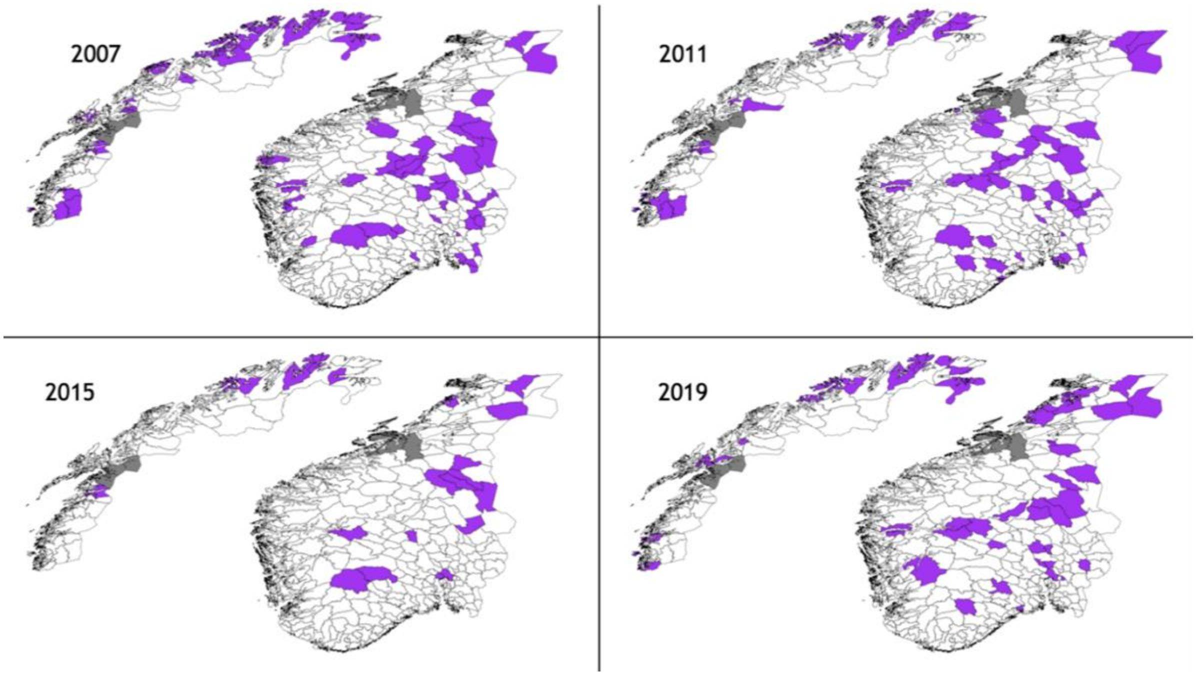
In order to test H1b, I employ the treatment of Green Party presence in the EC. Figure 6.3 shows this treatment over the different election periods. We can see that the Green Party has become present in many more ECs over the years. There were zero municipalities with Greens in the EC in 2007, two in 2011, 42 in 2011, and 71 in 2019. Figure 6.4 compares the covariate balance between the most efficient refinement method and without refinement.

Figure 6.4 Covariate balance for treatment 1



Note: Covariate balance between the treated and matched sets before and after treatment. The covariate balance for the other refinement methods used can be found in Appendix C.

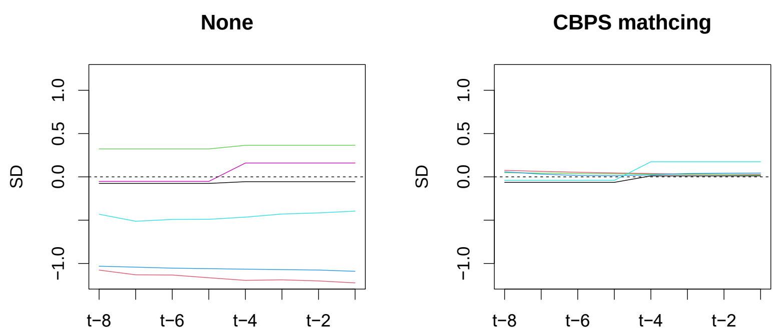
Figure 6.5 Municipalities with leftist party majorities in EC



Note: The figure shows an overview of treatment = municipalities with leftist party majorities in EC (2007-2021) for 351 out 356 Norwegian municipalities (2020 borders). Data source: (Miljødirektoratet 2022b).

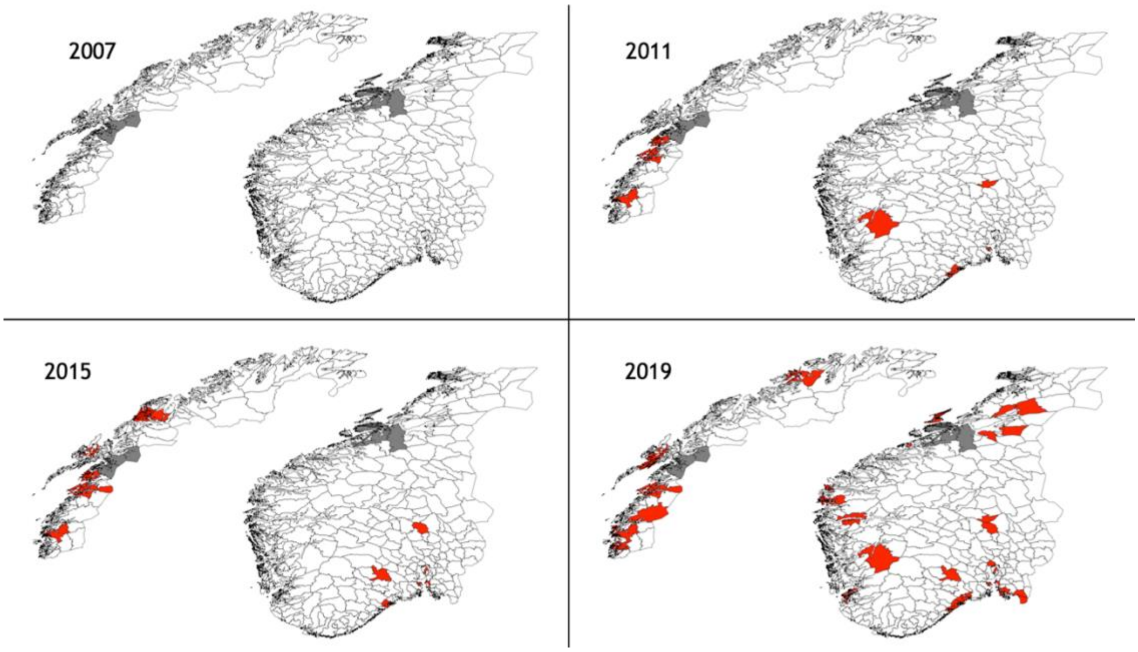
To test H2b I use leftist party majority in the EC as a treatment. Figure 6.5 shows that there has been quite a few municipalities with leftist majorities in the EC each election period. It went from 63 municipalities in 2007, 51 in 2011, to 21 in 2015, and 47 in 2019. Covariate balancing propensity score proved to be the most efficient refinement method. Figure 6.6 shows the covariate balance without refinement and with the best refinement.

Figure 6.6 Covariate balance for treatment 2



Note: Covariate balance between the treated and matched sets before and after treatment. The covariate balance for the other refinement methods used can be found in Appendix C.

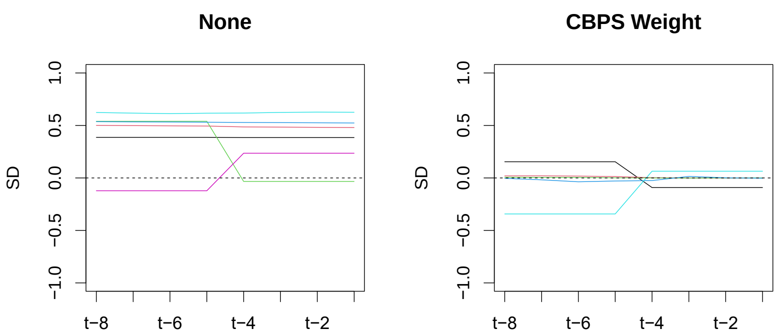
Figure 6.7 Municipalities with Rep party representatives in EC



Note: The figure shows an overview of treatment = municipalities with Red party presence (2007-2021) for 351 out 356 Norwegian municipalities (2020 borders). Data source: (Miljødirektoratet 2022b).

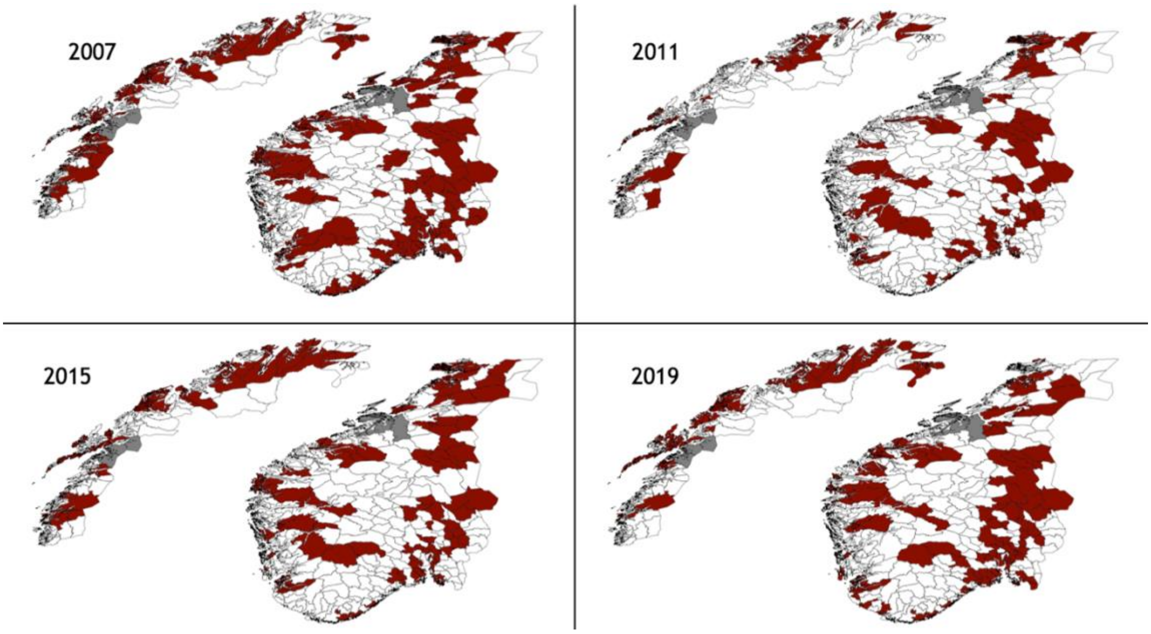
In order to test H2c about the effect of the different leftist parties, I use these parties as treatments. As we can see from Figure 6.7, the Red Party does not take part in many ECs, although more and more. From no municipalities in 2007, to 9 in 2011, 13 in 2015 and 33 in 2019. The best refinement method was covariate balancing propensity score weighting. Figure 6.8 shows the difference in covariate balance before and after refinement, and we can see that it is quite improved.

Figure 6.8 Covariate balance for treatment 3



Note: Covariate balance between the treated and matched sets before and after treatment. The covariate balance for the other refinement methods used can be found in Appendix C.

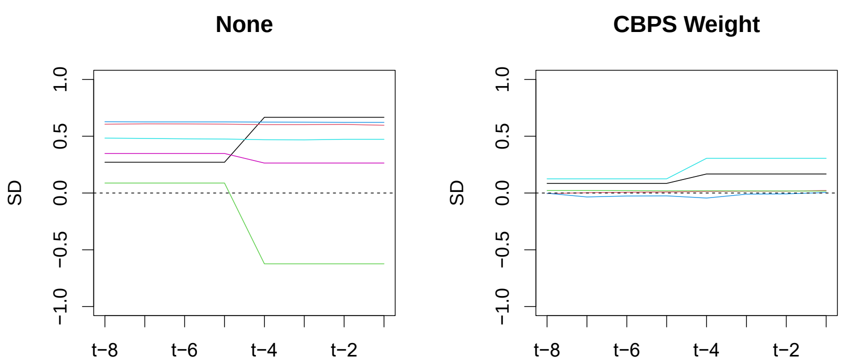
Figure 6.9 Municipalities with Socialist Left Party representatives in the EC



Note: The figure shows an overview of treatment = municipalities with Socialist Left Party presence in EC (2007-2021) for 351 out 356 Norwegian municipalities (2020 borders). Data source: (Miljødirektoratet 2022b).

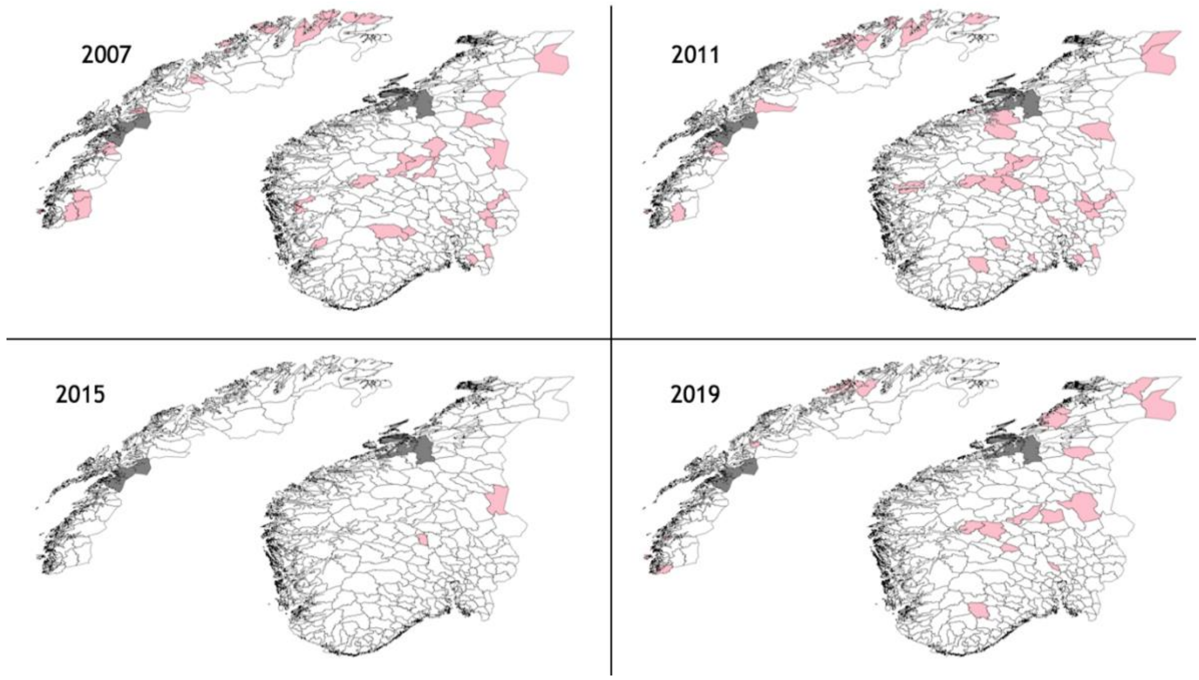
The Socialist Left Party participated in 142 ECs from 2007, 87 from 2011, 110 from 2015 and 126 from 2019. The best refinement method was covariate balancing propensity score weighting also in this case. Figure 6.10 shows the covariate balance before and after treatment.

Figure 6.10 Covariate balance for treatment 4



Note: Covariate balance between the treated and matched sets before and after treatment. The covariate balance for the other refinement methods used can be found in Appendix C.

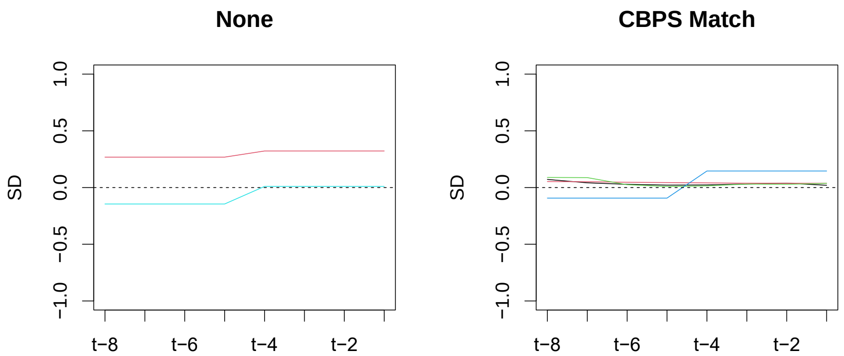
Figure 6.11 Municipalities with Labor Party majorities in the EC



Note: The figure shows an overview of treatment = municipalities with Labor Party majorities (2007-2021) for 351 out 356 Norwegian municipalities (2020 borders). Data source: (Miljødirektoratet 2022b).

The Labor Party is large enough to hold the majority in several municipalities. They had a majority in 35 ECs from 2007, 34 from 2011, 3 from 2015 and 20 from 2019. The best refinement method was covariate balancing propensity score matching. Figure 6.12 shows the covariate balance before and after refinement.

Figure 6.12 Covariate balance for treatment 5



Note: Covariate balance between the treated and matched sets before and after treatment. The covariate balance for the other refinement methods used can be found in Appendix C.

7 Results

In this chapter, I first present the results from the regression analysis and then the results from the panel matching. Table 7.2 shows the results from different OLS regression analysis models employing fixed effects. In Table 7.3 I present the results from the random effects regressions. Table 7.5 shows the results for the models employing the different emission sectors as dependent variables. I present the results from panel matching for each of the different treatments. Before going into the results, I briefly summarize the research design and hypotheses.

The research question is whether local level political parties can affect GHG emission levels in Norway. To test this, I employ data on the GHG emissions from all Norwegian municipalities between 2009 and 2021 and data on which political parties are present in the executive committee of the municipal council. I hypothesized that Green Party and leftist parties lead to lower GHG emissions, and that this effect will be mostly found in emissions stemming from road traffic, heating, and waste and sewage. I also hypothesized that the effect of the different leftist parties will be different, as climate change is an issue that cannot be neatly placed along a left-right dimension. While the two quantitative methods utilized look at the relationship between political parties and levels of GHG emissions, they do so in slightly different ways. The OLS regression analyses look at the relationship between increases in the different parties' seat share and the levels of emissions. Panel matching tests the difference in emissions levels between municipalities that have and municipalities that do not have either a specific party presence or a specific party majority. Table 7.1 shows the different hypotheses along with the method of testing for each of these.

Table 7.1 Hypotheses

Hypotheses			Method of testing
H1	a	**More Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.	OLS regression
	b	The **presence** of **Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality	Panel matching
H2	a	**More leftist** party representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.	OLS regression
	b	A **leftist party majority** in the executive committee of the municipal council leads to lower GHG emissions.	Panel matching
	c	The leftist parties will be associated with emissions reductions to different extents. The Socialist Left Party and the Red Party will be associated with more emissions reductions than the Labor Party.	OLS regression and panel matching
H3		Reduction in emissions related to municipal political parties will be within the sectors Heating, Waste and Sewage and Road Traffic.	OLS regression

7.1 Results from regression analyses

The fixed effects and the random effects analyses on the effect of parties on the total amount of emissions have fairly similar results, and this indicates that the findings are robust. Table 7.2 shows the results from the fixed effects models (Models 1-6) and Table 7.3 shows the results from the random effects models (Models 7-12). These models test H1a, H2a and H2c. Overall, the results show a correlation between Green Party representatives' seat share and lower levels of emissions which support H1a. Leftist parties' seat share does not show a statistically significant relationship with emission levels, and H2a is thus not supported. H2c is partially supported. The Red Party is associated with significantly lower levels of emissions than the Labor Party, while the Socialist Left Party is not. The Labor Party is even associated with higher levels of emissions after two years. I will now present the outputs of the regression analysis in closer detail.

Table 7.2 Fixed effects regression results with total emissions as dependent variable

	No lags		*1 year lag*		*2 year lag*	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Green Party	-0.0019 **	-0.0020 **	-0.0017 **	-0.0019 **	-0.0018 **	-0.0020 **
Leftist parties		0.0002		0.0001		0.0004
Labor Party	0.0002		0.0002		0.0006 *	
Socialist Left Party	0.0006		0.0003		0.0001	
Red Party	-0.0029 **		-0.0042 ***		-0.0046 ***	
Centre Party	-0.0007 *	-0.0007 **	-0.0011 ***	-0.0012 ***	-0.0008 **	-0.0008 **
Progress Party	0.0008 **	0.0009 **	0.0003	0.0004	-0.0002	-0.0002
Conservatives	0.0005	0.0005	0.0000	-0.0000	-0.0003	-0.0003
Christian Democrats	0.0011 **	0.0012 ***	0.0004	0.0004	-0.0004	-0.0004
Liberal Party	0.0005	0.0005	0.0000	-0.0000	-0.0003	-0.0004
Female representatives	-0.0005	-0.0006 *	-0.0004	-0.0005	-0.0004	-0.0005
Inhabitants	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***
Employment	0.0000 ***	0.0000 **	0.0000 **	0.0000 ***	0.0000 **	0.0000 **
Employed in industry	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***
Unit fixed effects	YES	YES	YES	YES	YES	YES
Obs.	3357	3357	3357	3357	3357	3357
R^2 / R^2 adjusted	0.075 / -0.037	0.070 / -0.042	0.070 / -0.043	0.062 / -0.051	0.067 / -0.047	0.058 / -0.056

Note: *The dependent variable is the natural logarithm of the total emissions.*

** p<0.05 ** p<0.01 *** p<0.001*

Table 7.3 Random effects regression results with total emissions as dependent variable

	No lags		*1 year lag*		*2 year lag*	
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Green Party	-0.0023 ***	-0.0024 ***	-0.0021 **	-0.0023 ***	-0.0020 **	-0.0022 ***
Leftist parties		0.0003		0.0003		0.0006 *
Labor Party	0.0003		0.0003		0.0008 **	
Socialist Left Party	0.0006		0.0003		0.0002	
Red Party	-0.0026 **		-0.0040 ***		-0.0044 ***	
Centre Party	-0.0005	-0.0006 *	-0.0009 ***	-0.0010 ***	-0.0006 *	-0.0007 *
Progress Party	0.0012 ***	0.0013 ***	0.0007 *	0.0008 *	0.0002	0.0002
Conservatives	0.0008 **	0.0008 **	0.0003	0.0003	-0.0000	-0.0000
Christian Democrats	0.0014 ***	0.0014 ***	0.0007 *	0.0007 *	-0.0001	-0.0001
Liberal Party	0.0007 *	0.0007	0.0002	0.0001	-0.0002	-0.0002
Female representatives	-0.0005	-0.0005	-0.0004	-0.0005	-0.0004	-0.0005
Inhabitants	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Employment	0.0000	0.0000	-0.0000	0.0000	-0.0000	-0.0000
Industry	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***
Obs.	3357	3357	3357	3357	3357	3357
Unit Random effects	YES	YES	YES	YES	YES	YES
R^2 / R^2 adjusted	0.065 / 0.061	0.062 / 0.059	0.058 / 0.055	0.053 / 0.050	0.053 / 0.049	0.045 / 0.042

Note: *The dependent variable is the natural logarithm of the total emissions*
** p<0.05 ** p<0.01 *** p<0.001*

The findings support H1a as an increase in the share of Green Party representatives is associated with lower levels of GHG emissions across all models. This relationship is shown in the same year (Model 1, 2, 7, and 8), the following year (Model 3, 4, 9, and 10) and two years after (Model 5, 6, 11, and 12). Both the fixed effects and random effects regression analyses indicate that the Green Party is associated with lower levels of emissions. This association is statistically significant at the $P<0.01$ level in the fixed effects models and at $P<0.001$ in the random effects models. It is thus well within the default threshold at $P<0.05$ for establishing statistical significance. Since the dependent variable is log-transformed, the results are not intuitively interpreted. They can, however, be interpreted approximately as a percentage change. This means that Model 1 indicates that a one percentage point increase in Green Party representatives is associated with 0.19 percent lower GHG emissions levels.

The results do not support hypothesis 2a concerning the effect of leftist parties. This hypothesis is tested by the independent variable named Leftist parties, which measures the percentage share of the Labor Party, Socialist Left Party, and Red Party in the EC. Models 2, 4, 6, 8, 10, and 12 include this composite variable. None of these models, except for Model 12, show a statistically significant relationship between leftist party seat share and emissions reductions. The numbers are all positive, signifying higher levels of emissions, although not statistically significant. However, Model 12, which is a random effects model where the independent variables are lagged two years, shows a small yet positive relationship. This relationship is statistically significant at the 0.05 level. This indicates that a one percentage point increase in the seat for the leftist parties is associated with 0.06 percent *higher* GHG emissions levels after two years.

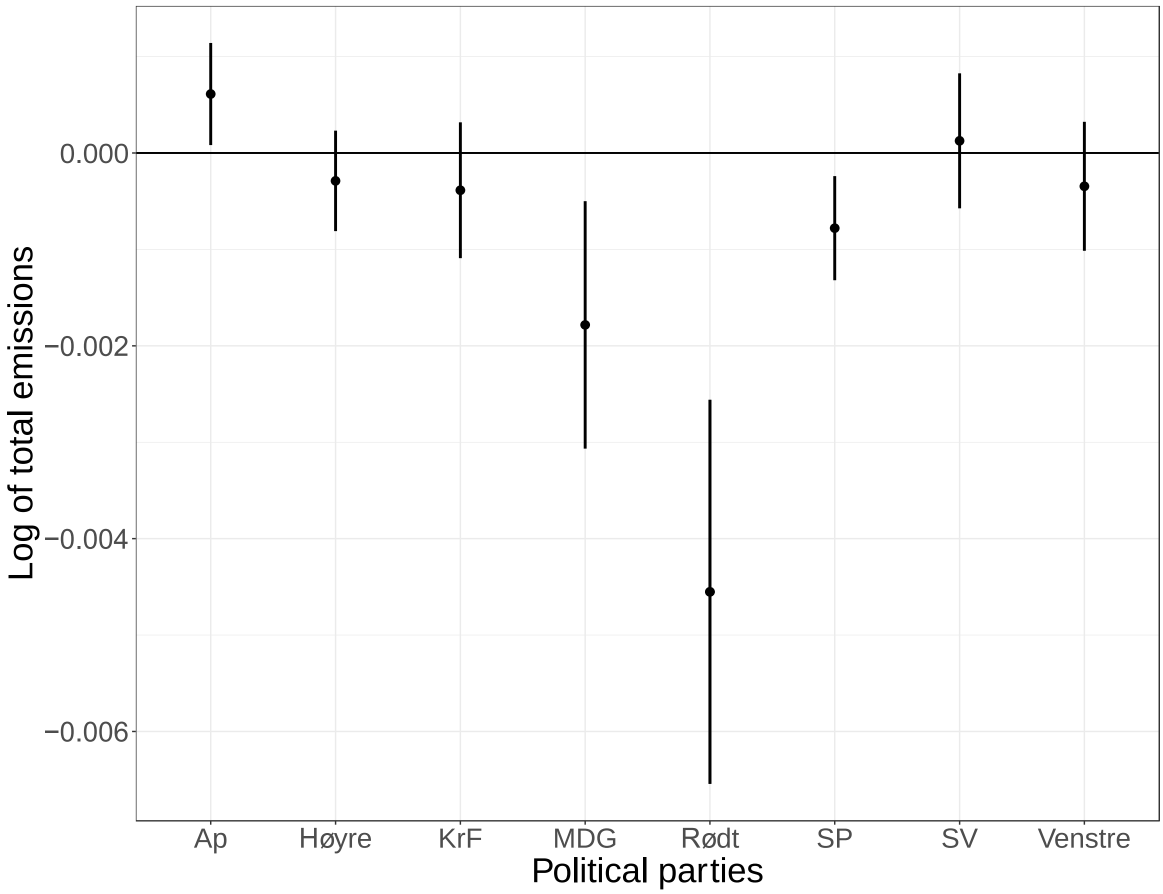
Hypothesis 2c regarding the effect of the leftist parties separately is partly supported by the results. I test this hypothesis in Model 1, 3, 5, 7, 9 and 11. Here the three leftist parties are included as separate independent variables. The Labor Party is not associated with changes in emissions at a statistically significant level immediately (Model 1 and 7) or after one year (Model 3 and 9). However, when the Labor Party variable is lagged two years, there is a positive relationship with the level of GHG emissions both using fixed effects (Model 5) and random effects (Model 12). These models indicate that a percentage point increase in the seat share of Labor Party representatives is associated with between 0.06 percent and 0.008 percent higher levels of GHG emissions after two years.

Contrary to expectations, the Socialist Left Party is not associated with any changes in emissions levels at a statistically significant level. The estimates are positive in all models, indicating that the Socialist Left Party might be associated with higher rather than lower levels of GHG emissions.

The Red Party, on the other hand, is associated with statistically significant lower levels of GHG emissions in all models. Model 1 and 7 indicates that a 1 percent increase in Red Party seat share is associated with between 0.26 percent and 0.29 percent lower levels of GHG emissions the same year. Model 3 and 9 indicates that the effect one year after is between 0.40 percent and 0.42 percent. Model 5 and 11 imply that after two years, 1 percent increase in Red Party representatives is associated with between 0.44 percent and 0.46 percent lower levels of GHG emissions. All these results are statistically significant at the 0.01 or 0.001 level.

Although the hypotheses did not consider the effects of the other parties, the results are interesting to present. The Centre Party is associated with lower levels of emissions, both immediately, after one year and after two years. The size of the relationship is, however, smaller than for the Red Party and the Green Party. The Progress Party is associated with higher levels of emissions the same year in the fixed effects models. In the random effects models the Progress Party is also associated with higher levels of emissions after one year. The Conservative Party is not associated with changes in emissions levels at a statistically significant level in the fixed effects models. In the random effects models, an increase in the share of seats for the Conservative Party is, however, associated with higher levels of GHG emissions the immediate year. The Christian Democrats are associated with higher levels of emissions the immediate year in both the fixed and random effects models. In the random effects models they are also associated with higher levels the following year. The Liberal Party is associated with slightly higher levels of emissions the immediate year in the random effects model. Except for this, there are no statistically significant relationships between the Liberal Party and emissions levels. Figure 7.1 shows the relationship between the different parties and the levels of emissions. The basis for the figure is Model 5, which is a fixed effects model with two-year-lagged political variables.

Figure 7.1 Results from regression analysis shown graphically



***Note**: The figure shows the relationship between the different political parties and the log-transformed GHG emissions. It is a fixed effect model with a two year lag of independent variables. Confidence intervals are at the 95 percent level.*

As mentioned in Chapter 6, time trends can also affect the results. Table 7.4 on the next page shows the results from regression analyses that also controls for time trends. Models 13 to 15 are two-way random effects, and Models 16 to 18 are two-way fixed effects. In most of these models, the relationship between Green Party representatives and lower levels of GHG emissions is no longer statistically significant, except for in Models 13 and 14. However, although not statistically significant, the estimates are all still negative. The relationship between the Red Party and lower levels of emissions remains statistically significant across all models.

Table 7.4 Regression results - controlling for time trends

	Two-way random effects			Two-way fixed effects		
	No lags	1 year lag	2 years lag	No lags	1 year lag	2 years lag
	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18
Green Party	-0.0015 *	-0.0013 *	-0.0011	-0.0006	-0.0002	-0.0003
Labor Party	0.0003	0.0003	0.0004	0.0004	0.0002	0.0003
Red Party	-0.0019 *	-0.0029 **	-0.0033 ***	-0.0016	-0.0025 **	-0.0031 **
Socialist Left	0.0006	0.0004	0.0002	0.0006	0.0004	0.0004
Centre Party	0.0003	-0.0002	-0.0002	0.0002	-0.0003	-0.0003
Christian Democrats	0.0010 **	0.0003	-0.0002	0.0008 *	0.0001	-0.0002
Right wing parties	0.0007 **	0.0004	0.0002			
Progress Party				0.0003	-0.0001	-0.0001
Conservatives				0.0004	0.0000	-0.0001
Liberal Party				-0.0001	-0.0004	-0.0003
Female representatives				-0.0000	0.0001	0.0001
Inhabitants	0.0000	0.0000	-0.0000	-0.0000 ***	-0.0000 ***	-0.0000 ***
Employment				0.0000 *	0.0000 *	0.0000 *
Industry				0.0000 ***	0.0000 ***	0.0001 ***
Obs.	3510	3510	3510	3357	3357	3357
R^2 / R^2 adjusted	0.010 / 0.008	0.009 / 0.006	0.007 / 0.005	0.029 / -0.092	0.029 / -0.092	0.030 / -0.091
Two-way random effects	Yes	Yes	Yes			
Two-way fixed effects				Yes	Yes	Yes

Note: *The dependent variable is the natural logarithm of the total emissions*

** p<0.05 ** p<0.01 *** p<0.001*

Table 7.5 on the next page shows the results from fixed effects regression analyses using the log-transformed emissions from the different sectors as the dependent variables. The models include political variables that are lagged two years. This means that the results can be interpreted as the effect political parties have on emissions after two years. The results support H3, as both the Red Party and the Green Party are associated with lower levels of emissions from road traffic, heating, and waste and sewage.

The Green Party is associated with lower levels of emissions in several sectors. The share of Green Party representatives is associated with lower levels of emissions from road traffic, waste and sewage, air traffic, and heating at $P<0.05$ significance level. These results do, therefore, also support Hypothesis 1a. The Red Party is also associated with lower levels of emissions in these sectors. Interestingly, both the Red Party and the Green Party are associated with higher levels of emissions from energy supply. Overall the Red Party and the Green Party seem to follow very similar patterns. The Red Party is, however, associated with even lower levels of emissions than the Green Party across all sectors.

Neither the Labor Party nor the Socialist Left Party is associated with any statistically significant changes in the levels of emissions within any of the different sectors. The Labor Party is even associated with higher levels of emissions from road traffic, waste and sewage, and heating. Interestingly, the Centre Party is associated with lower levels of emissions from road traffic and heating. And the relationship between the Centre Party and lower levels of emissions is therefore strengthened.

Table 7.5 Unit fixed effects regression results for the different sectors

	Road Traffic	Waste and Sewage	Air Traffic	Energy supply	Agriculture	Heating	Industry, oil and gas	Other mobile combustion	Sea Traffic
Green Party	-0.0043 ***	-0.0046 **	-0.0054 *	0.0178 **	0.0000	-0.0191 ***	-0.0094	0.0030	-0.0094
Labor Party	0.0005 *	0.0031 ***	-0.0001	0.0014	-0.0002	0.0041 ***	-0.0006	-0.0013	-0.0006
Red Party	-0.0055 ***	-0.0081 **	-0.0086 **	0.0293 **	0.0007	-0.0319 ***	0.0014	0.0033	0.0014
Socialist Left Party	-0.0001	0.0008	-0.0005	-0.0009	-0.0006	-0.0020	0.0008	0.0010	0.0008
Centre Party	-0.0020 ***	-0.0005	-0.0006	-0.0014	0.0001	-0.0096 ***	-0.0034	-0.0000	-0.0034
Progress Party	0.0009 ***	0.0017 *	0.0008	0.0041	0.0013	0.0033 **	-0.0062	-0.0003	-0.0062
Conservatives	-0.0002	0.0000	0.0002	0.0035	-0.0003	-0.0026 **	-0.0044	0.0024 ***	-0.0044
Christian Democrats	0.0009 **	0.0024 *	0.0001	0.0067	-0.0021 *	0.0021	-0.0016	-0.0001	-0.0016
Liberal Party	0.0010 ***	0.0014	0.0005	0.0013	-0.0003	0.0021	-0.0007	0.0007	-0.0007
Female representatives	-0.0018 ***	-0.0007	-0.0008	-0.0004	0.0011	-0.0087 ***	0.0040	0.0016 *	0.0040
Inhabitants	-0.0000 ***	-0.0000	-0.0000	0.0000	0.0000	-0.0000 ***	-0.0000	0.0000 *	-0.0000
Employment	0.0000 ***	0.0000	0.0000	0.0000	-0.0000	0.0000 ***	0.0000	-0.0000	0.0000
Industry	0.0001 ***	0.0001 **	0.0001	-0.0007 ***	-0.0000	0.0002 **	0.0004 *	0.0000	0.0004 *
Obs.	3357	3357	3357	3357	3357	3357	3357	3357	3357
R^2 / R^2 adjusted	0.250 / 0.159	0.040 / -0.076	0.011 / -0.109	0.024 / -0.095	0.005 / -0.115	0.244 / 0.153	0.008 / -0.113	0.022 / -0.097	0.008 / -0.113

Note: *The dependent variable is the log-transformed emissions from each sector. The political variables (parties and female representatives) are lagged 2 years.*

** p<0.05 ** p<0.01 *** p<0.001*

7.2 Results from panel matching

This subsection presents the results from the panel matching analyses. The results from panel matching are measured as the average treatment effect of the treated (ATT) using a Difference-in-Difference (DiD) estimator. In order to find this effect, the counterfactual outcome is calculated using the weighted average in the control units in the refined matched sets. The difference-in-difference estimate is then calculated for each of the treated observations, and then averaged across all treated observations (Imai et al. 2021, 10). I have performed five different panel matching analyses, with different treatments. Table 7.6 summarizes the different treatments together with the related hypotheses.

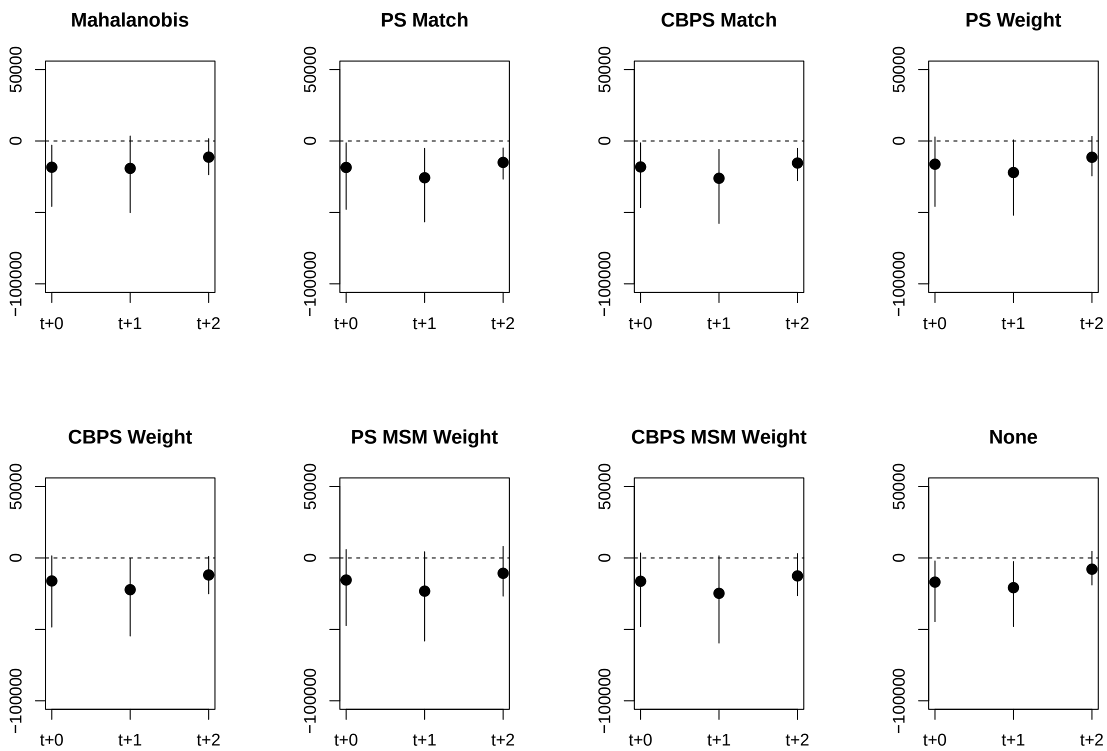
Table 7.6 Recap of the different treatments used in panel matching

Treatments	**Hypotheses**
(1) Green Party presence in the EC (Green Party representatives > 0).	1b
(2) Leftist party majority in the EC (Leftist party seat share > 50%).	2b
(3) Red Party presence in the EC (Red Party representatives > 0) .	2c
(4) Socialist Left Party presence in the EC (Socialist Left Party > 0).	2c
(5) Labor Party majority in the EC (Labor Party seat share > 50%).	2c

The results from the different treatments are presented in Figure 7.2, 7.4, 7.5, 7.6, and 7.7. Each of these figures contain eight different plots. The different plots within the figures represent the different refinement methods used, and the plot in the bottom right corner is the results from without refinement. Being above the dotted reference line indicates that the ATT is a *higher* level of GHG emissions. Being below the dotted line indicates a *lower* level of GHG emissions. The horizontal line indicates the time after treatment: immediately (t+0), one year after (t+1), and two years after (t+2). The black dots represent the estimates, and the lines connected to the dots represent the confidence intervals at the 95 percent level.

The first treatment is Green Party presence in the executive committee of the municipal council and is related to Hypothesis 1b. This means that the results indicate the estimated average difference for those municipalities that do have one or more Green Party representatives in the EC and those that do not. The results using different refinement methods are shown in Figure 7.2. The general picture is that of a lower level of emissions. All of the refinement methods indicate negative estimates, which means that the average effect of having Green Party representatives is lower levels of emissions. This aligns with the findings of the regression analysis discussed earlier. Whether the effect is statistically significant varies between the different refinement methods. The refinement method with the best covariate balance was propensity score weighting, shown in the top right corner. The results represent the difference in emissions levels between having and not having Green representatives, and this difference is approximately 16 000 tonnes of CO_2 equivalents lower the immediate year, 22 000 tonnes lower one year after, and 11 000 tonnes lower two years after.

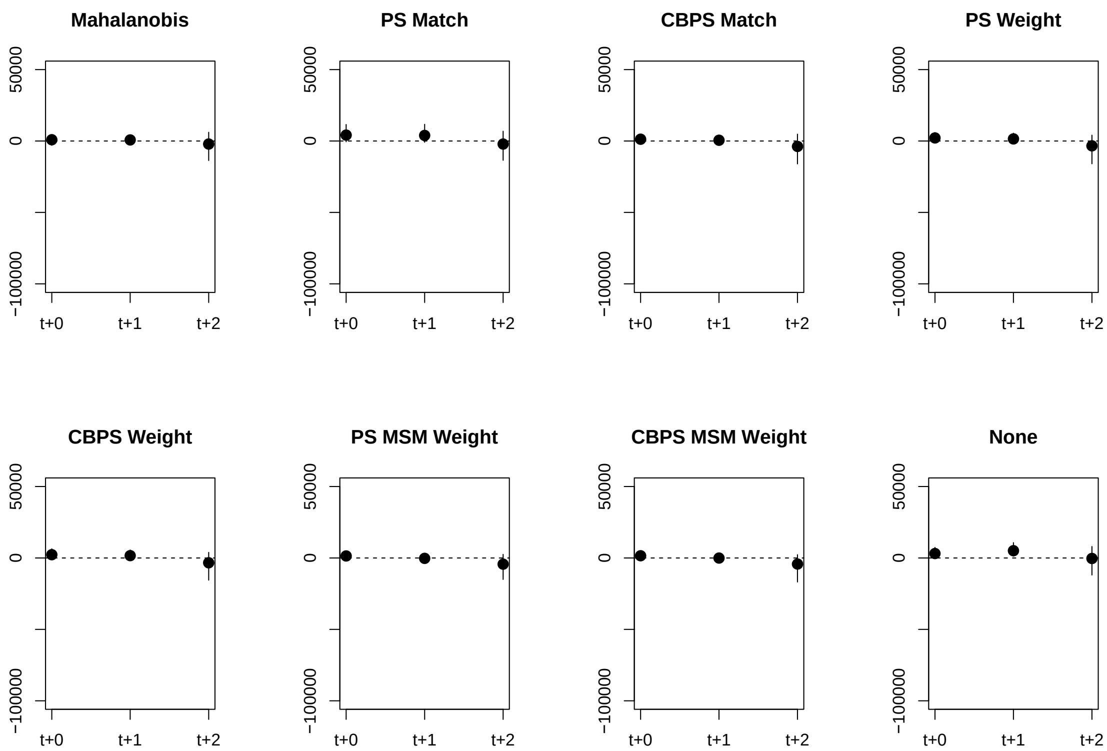
Figure 7.2 Estimated average effects of Green Party presence in EC on GHG emissions



Note: *All the different refinement methods adjust for treatment and covariate history up to 8 years prior to the treatment (L = 8). The estimates of the average effects are shown for a period of 3 years (F = 0:2), with 95 percent confidence intervals as vertical bars.*

The second treatment I test, is having a leftist party majority in the executive committee of the municipal council. The results from this analysis are shown in Figure 7.3. As the plots indicate, a leftist party majority in the executive committee of the municipal council, does not seem to make much of a difference. The results show the average treatment effect of the treated as compared to the matched sets that have not been treated. This means that a value close to zero indicates that having a leftist party majority does not differentiate municipalities when it comes to emissions levels. The results do not differ much between the different refinement methods. The refinement method with the best covariate balance was Covariate Balancing Propensity Score (CBPS) matching. The estimates using this method indicate slightly higher levels the immediate year and first year after, and slightly lower levels two years after the treatment. The confidence interval does however go both above and below zero for each of the years, indicating that the effect might be both positive and negative.

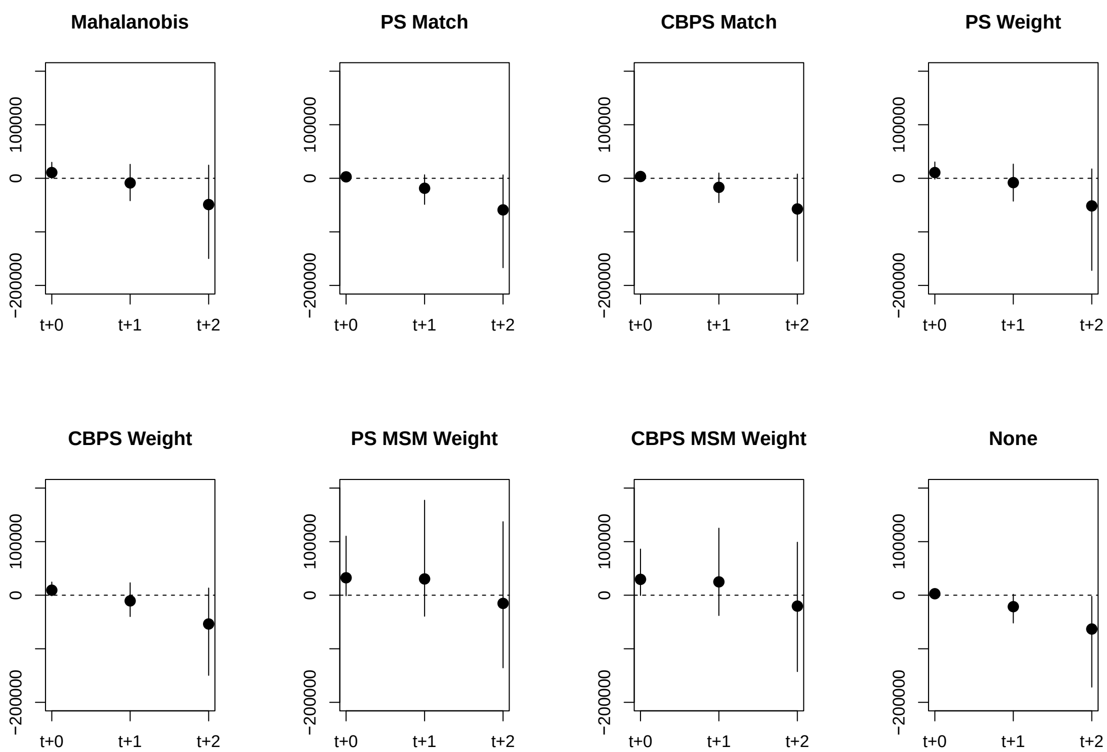
Figure 7.3 Estimated average effects of leftist party majority in EC on GHG emissions



Note: *All the different refinement methods adjust for treatment and covariate history up to 8 years prior to the treatment (L = 8). The estimates of the average effects are shown for a period of 3 years (F = 0:2), with 95 percent confidence intervals as vertical bars.*

The third treatment is Red Party presence in the executive committee of the municipal council. Here, the results do *not* indicate a statistically significant impact of Red Party presence on GHG emissions. There are also very large confidence intervals. The Red Party does, however, seem to be related to lower levels of emissions after two years, and this effect is potentially larger than the effect of Green Party presence. The effect varies quite a bit between the different refinement methods, and the confidence intervals go both above and below zero. The refinement method with the best covariate balance was CBPS weighting shown in the bottom left corner. The estimates for this model is about 900 tonnes higher levels the immediate year, and then 11 000 tonnes lower the year after, and 54 000 tonnes lower the year after that again. However, the confidence intervals are large.

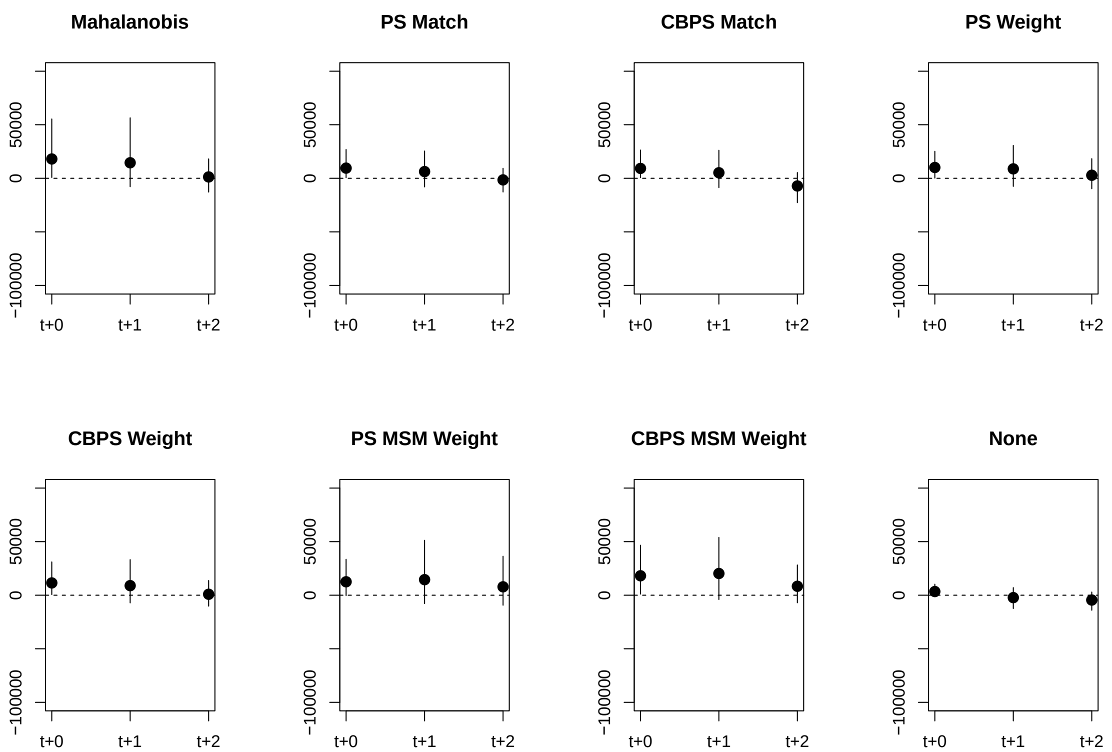
Figure 7.4 Estimated average effects of Red Party presence in EC on GHG emissions



Note: *All the different refinement methods adjust for treatment and covariate history up to 8 years prior to the treatment (L = 8). The estimates of the average effects are shown for a period of 3 years (F = 0:2), with 95 percent confidence intervals as vertical bars.*

The fourth treatment is Socialist Left Party presence in the executive committee of the municipal council. The results are shown in Figure 7.5. The presence of the Socialist Left Party is indicated to lead to higher levels of emissions the first year. The following two years do not show a significant positive or negative effect. The refinement method that provided the best covariate balance was CBPS weighting. The estimates using this refinement method indicate that municipalities with Socialist Lefts in the EC has higher levels than those that do not. The difference is 18 000 tonnes the immediate year, 20 000 tonnes the first year after, and 8 000 tonnes two years after.

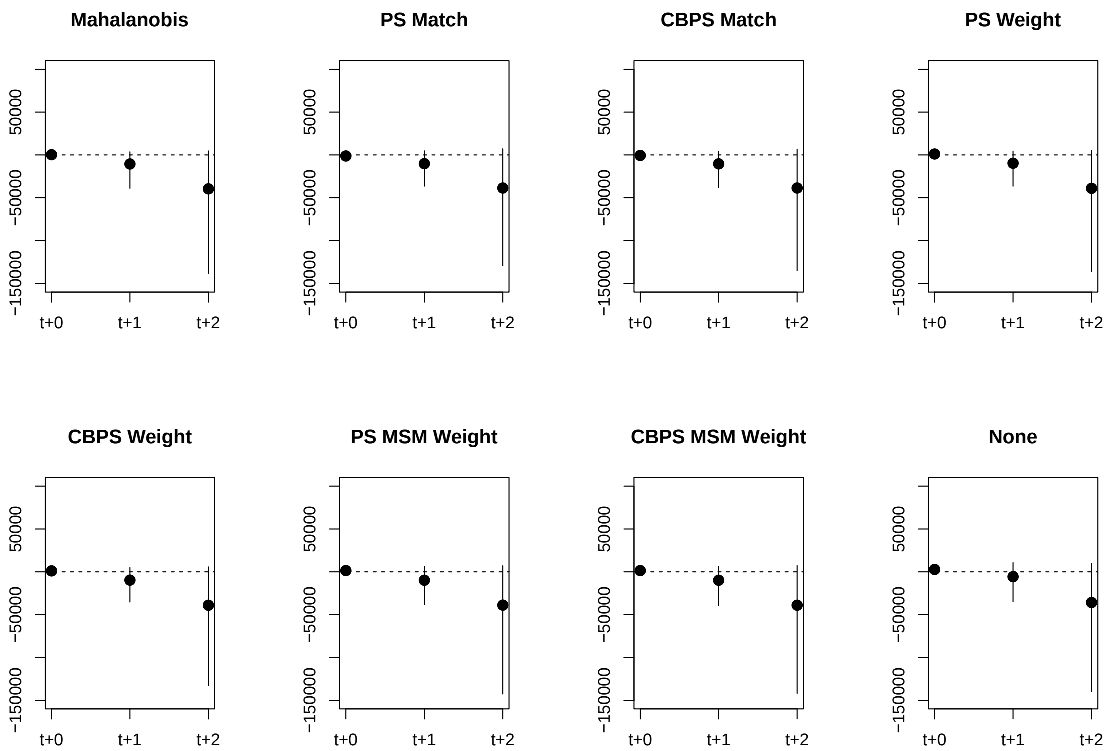
Figure 7.5 Estimated average effects of Socialist Left Party presence in EC on emissions



Note: *All the different refinement methods adjust for treatment and covariate history up to 8 years prior to the treatment (L = 8). The estimates of the average effects are shown for a period of 3 years (F = 0:2), with 95 percent confidence intervals as vertical bars.*

The fifth treatment is having a Labor Party majority in the EC. Figure 7.6 shows the results from panel matching using this treatment. The results are not clearly negative or positive, but all the dots are below zero, which indicates that a Labor Party majority might be associated with lower levels of GHG emissions. Covariate balancing propensity score matching proved to be the refinement method with the best covariate balance in this case. The estimates using this method indicate that the effect of having a Labor Party majority is that of a lower level of emissions of about 600 tonnes the immediate year, 10 000 tonnes the first year after, and 39 000 tonnes two years after.

Figure 7.6 Estimated average effects of Labor Party majority in EC on GHG emissions



Note: *All the different refinement methods adjust for treatment and covariate history up to 8 years prior to the treatment (L = 8). The estimates of the average effects are shown for a period of 3 years (F = 0:2), with 95 percent confidence intervals as vertical bars.*

8 Discussion/conclusion

I here discuss the findings of the statistical analyses in light of the theoretical framework presented in Chapter 3. The hypotheses guide the discussion as I reflect upon the implications of the results for the different hypotheses. I then move on to consider the limitations of this study. Finally, I consider some avenues for further research.

In this thesis, I have conducted a panel regression analysis and panel matching to test the relationship between local political parties and GHG emissions. The thesis can be placed in the intersection between the literature on political parties, local level politics, and environmental politics. Environmental politics, especially climate change, is a policy domain that challenges traditional political cleavages. To investigate how the different parties perform regarding climate change mitigation is therefore interesting from a theoretical point of view, as it can shed light on how the environmental political dimension relates to the left-right and other political dimensions. Moreover, the local political level performs essential tasks, making it a key arena for climate change mitigation. Yet the politics of local level climate change mitigation has not been subject to many quantitative studies.

The research question was whether local political parties affect GHG emissions in Norway. I hypothesized that Green and leftist parties in the EC would lead to lower levels of emissions and that these differences would be in the sectors the municipalities have authority within. Table 8.1 recaps the hypotheses, along with the method of testing and the assessment of each. I performed both fixed and random effects regression analyses and regression analyses using the different emission sectors as dependent variables. I also conducted five different panel matching analyses with different treatments. Both the Red Party and the Green Party seem to be connected to lower levels of emissions. The results support the assumption that *parties matter*. Moreover, they indicate that the local political level is an arena where impactful decisions can be made. I will now discuss the results in light of each of the hypotheses.

Table 8.1 Assessment of hypotheses

Hypotheses			Method of testing	Assessment
H1	a	**More Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.	OLS regression	Supported
	b	The **presence of Green Party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality	Panel matching	Supported
H2	a	**More leftist party** representatives in the executive committee of the municipal council leads to lower GHG emissions in the municipality.	OLS regression	Not supported
	b	A **leftist party majority** in the executive committee of the municipal council leads to lower GHG emissions.	Panel matching	Not supported
	c	The leftist parties will be associated with emissions reductions to different extents. The **Socialist Left** and the **Red Party** will be associated with more emissions reductions than Arbeiderpartiet.	OLS regression and panel matching	Partially supported.
H3		Reduction in emissions related to municipal political parties will be within the sectors Heating, Waste and Sewage and Road Traffic.	OLS regression	Supported

Hypothesis 1a concerned the Green Party's effect on GHG emissions and is strongly supported by the results. In both the fixed and random effects models, the increase in the seat share of the Green Party was associated with lower levels of emissions. This relationship was also highly significant. Some of the effect did, however, disappear when controlling for time trends by employing random and fixed effects on time. This does not necessarily mean the effect is only due to a time trend. As the Greens have grown in recent years and the reductions in emissions have happened in recent years, the effect can be difficult to discern. Many municipalities have had lower levels of emissions since 2019 and the Greens have been in ECs since the 2019 election. Some of the association between the Green Party and lower levels of emissions might be due to the fact that the Greens have been in office in years characterized by lower levels of emissions. However, as there are not that many examples of Greens in ECs before 2019, controlling for time trends might also entail controlling away something that is actually there.

The estimates are still negative, indicating lower levels of emissions, in the models where the statistical significance of the relationship disappears. Since I include all units except for five, we can still, with quite a lot of certainty, say that the Green Party has been associated with lower levels of emissions in Norwegian municipalities in the time period 2009 to 2021.

Hypothesis 1b concerned the effect of Green Party presence in the EC on emissions levels. By employing panel matching, I attempted to control for societal factors and improve causal inference. The panel matching results indicate the difference in developments between similar municipalities that have and have not had Green Party representatives in the executive committee of the municipal council. As this method employs a difference-in-difference estimator, it does control for possible time trends. The results of the panel matching analysis indicate that the presence of Green Party representatives in the EC results in lower levels of emissions. The statistical significance of the effect varies a bit between the different refinement methods. It is, however, a clear indication of lower levels of GHG emissions in the immediate year, one year after, and two years after the Green Party enter the EC. Consequently, Hypothesis 1b is also strongly supported. The seeming success of the Green Party in reducing emissions is in line with a partisan theory framework as the Green Party has climate change mitigation as a core part of their ideology.

It is rather surprising that there seems to be an effect of the Green Party on emissions the year they enter office. Municipal elections are in September. It can be discussed how plausible it is that they can affect that year's emissions within the three months that remain of the year. One explanation could be that there are more Green representatives in the municipal councils (but not in the ECs) leading up to the year the Greens enter the EC in these municipalities. I do not match municipalities on municipal council members. This means that some of the effect could be due to work Green representatives do as municipal council members in the years leading up to the entrance of Greens into the EC. The effect the immediate year could, however, also be spurious.

Hypothesis 2a and 2b concerned leftist parties as a group and are not supported by the results. Although environmental politics represents its own political dimension, the left-right political dimension is often theorized and shown empirically to be useful in explaining environmental policy outputs and outcomes. The idea is that leftist parties are prone to reduce emissions. The parties considered leftist in this thesis are the Red Party (Rødt), the Labor Party (Ap), and the

Socialist Left Party (SV). Both in the regression analyses and the panel matching, no effect is found of leftist parties as a group on GHG emissions. This indicates that the left-right axis might not be a good indication of climate change mitigation performance in local level politics in Norway. The lack of effect of the leftist parties as a group supports using a multidimensional partisan approach in the study of climate change mitigation politics. An analysis that dichotomously separates left and right misses out on important nuances.

Hypothesis 2c concerned the effect of the three leftist parties separately. Considering these parties on their own gives another picture than grouping them together. In the regression analysis, the Labor Party was associated with an increase in emissions after two years. The immediate effect was not statistically significant but also pointed in the direction of higher levels. The Socialist Left Party was not significantly associated with emissions, but the results also pointed towards higher levels of emissions. The results from the panel matching where Labor Party majority and Socialist left presence are used as treatments do not indicate any statistically significant higher or lower levels of emissions.

Red Party representatives, however, seem to be strongly associated with lower levels of emissions. In the regression analysis, the Red Party is associated with even lower levels of emissions than the Green Party. The association between the Red Party and lower emissions remains statistically significant also when controlling for time trends by employing random and fixed time effects. The effect is not as clear in the panel matching results, however. The effect here also seems to be a reduction after two years, but the confidence intervals stretch above and below zero. The Red Party is small and only part of a few executive committees. The results from the panel matching show very large confidence intervals, which might be related to the relatively small sample. The overall picture is, however, that the Red Party is associated with lower levels of emissions.

As the Red Party is the party furthest to the left on the left-right axis, their success could be interpreted in the direction that this axis matters for explaining environmental outcomes. However, since there is no effect of the other two parties on the left, this does not seem that plausible. Contrastingly, it seems more plausible that this is an indication that the left-right axis does *not* provide much explanatory power. Other explanations for the success of the Red Party are therefore more likely.

The expectation was that the Labor Party was not going to be associated with lower emissions to the same degree as the Red Party and the Socialist Left Party. The surprising finding is therefore that the Red Party and the Socialist Left Party are associated with significantly different results. In a party family approach, these two parties would often be grouped together. Considering them on a left-right axis would also entail grouping them close to each other. Moreover, the Socialist Left Party has a strong environmental profile. The theoretical framework does not clearly indicate why the Red Party and the Socialist Left Party should show such differing results. The results suggest that we need to think differently about these parties.

The Socialist Left Party differ from the Red Party in that they have participated in government at the national level together with the Labor Party. Based on the cartel party theory, one could imagine they might have developed more cartel-like structures due to previous government participation. However, this interpretation conflicts with the image of the Socialist Left Party. They seem to have a relatively flat structure and decide important matters by voting among their members. The Socialist Left Party might have less effect since they cooperate more with the Labor Party. However, as the models include the Labor Party as a variable, this should be controlled for in the regression analyses. However, it might be that the general connection to the Labor Party has made the Socialist Left Party more similar to them. The histories of the Red Party and the Socialist Left Party are also different, and there could be several institutional and ideological reasons why they perform differently.

A surprising and interesting result is the fact that the Centre Party seems to be associated with lower levels of emissions. The Centre Party does not have a very strong environmental profile. The Centre Party could be grouped as a leftist party as the party has been in coalitions at the national level with both the Labor Party and the Socialist Left Party. An explanation based on the theoretical framework presented in this thesis is that the Centre Party is successful due to its leftist position on the left-right axis. However, as the other leftist parties, the Socialist Left and the Labor Party, were not associated with lower levels of emissions, the left-right axis does not seem to be an explanation for climate change mitigation performance.

Taking a more multi-dimensional party family perspective does not necessarily explain why the Centre Party should lead to lower levels of GHG emissions either. The GAL-TAN axis puts green, alternative, and libertarian against traditional, authoritarian, and nationalist. The Chapel

Hill Expert Survey places the Centre Party far over at the TAN side of the axis (Stein 2023, 45). This means that the GAL-TAN axis seems unsuited to explain the possible success of the Centre Party when it comes to emissions. The Centre Party was founded in 1920 as an agrarian party in opposition to industrialization and urbanization (Senterpartiet 2022). Taking a party family approach, one could argue that their origin and ideology has elements to them that could be inducive for climate change mitigation, as both industrialization and urbanization can have detrimental effects on the environment.

Using these partisan frameworks does not seem to give sufficient explanation for why the Centre Party might be successful in providing lower levels of emissions. It might be that the local level as a political arena functions differently than the national level. The Centre Party has a regional and local focus and has held office in many municipalities for a long time. We might expect them to act differently at the local level than at the national level. It might be that, even though they do not have a strong environmental profile, they have chosen the right and efficient policies in order to reduce emissions. When looking into the different sectors, we see that the relationship between the Center party and lower levels of emissions is found within Road Traffic and Heating. These are both sectors where incentives, such as economic support to better insulation or perks for driving electric cars, can be expected to make a difference.

Hypothesis 3 was that the political parties would be able to affect the emissions levels in the sectors of road traffic, waste and sewage, and heating. The effect of the political parties on GHG emissions is found in these expected sectors, and H3 is thus strengthened. Both the Red Party and the Green Party are associated with lower levels of emissions within road traffic, waste and sewage, and heating. The hypothesis was created based on the competencies and authorities the municipalities have. The municipalities have the sole responsibility for household waste collection and handling, and they could therefore affect emissions from this sector. The municipalities do not have the main responsibility regarding road traffic, but they have some important competencies allowing them to take significant measures. When it comes to heating, the municipalities are expected to be able to make changes in their own buildings, through economic aid to household improvements such as better isolation, and through their role as land-use planners.

However, there are some surprising findings. Firstly, both the Red and Green Party seem to be able to affect emissions stemming from air traffic, which is not a specific competency for the municipalities. The data on air traffic emissions only includes the emissions related to the departure and arrival phase of airplanes and helicopters, meaning before and after the aircraft is above 3000 feet (Miljødirektoratet 2022a, 50). The municipal governments have authority regarding expansions, openings, and closures of airports through their role as land-use planners, and they might affect the amount of air traffic through this.

Interestingly, both the Red Party and the Green Party are associated with higher levels of emissions from energy supply. This sector includes incineration, district heating, electricity production, and other energy supplies (Miljødirektoratet 2022a). A possible explanation could be that reducing emissions within the other sectors is related to higher levels of emissions within this sector, as it is related to creating energy and turning waste into energy. However, it is also possible that the policy packages of the Red Party and the Green Party de-prioritize emissions reductions in this sector.

The results from the regression analyses are presented as the change in emissions when the seat share of a political party increases by one percentage point. Of course, representatives do not enter the executive committees as percentage points but as people. Knowing the average effect of one representative would make the results more intuitive. The executive committees in the dataset vary between 3 and 43 members. The mean is seven members, and the average is 8.6, so I use eight members as a representative number. If there are eight members in an EC, that means that each member corresponds to a 12.5 percent share of the committee. If we then use the unit fixed effects regression analysis where the parties are lagged two years (Model 5) as an example, we can paint a picture of what the effect of the different representatives may look like. In this model, a one percentage point increase in Green Party representatives is associated with 0.18 percent lower levels of emissions, and a one percentage point increase in Red Party representatives is associated with 0.46 percent lower levels of emissions. An average Green Party member will then be associated with 2.25 percent lower levels and a Red Party representative with 5.75 percent lower levels. Following this logic, an EC of only Green representatives would entail 18 percent lower levels of emissions and an EC with only Red Party with 46 percent. This is, of course, a very stylized example, but it does say something about the effect size.

8.1 Limitations

Almost all research circles around the question of causality. On the one hand, it is what we are truly interested in, but it is, on the other hand, almost impossible to prove. The causal mechanisms between two variables are seldom completely clear. In this analysis, the focus has *not* been on the causal mechanisms between party presence and the level of GHG emissions. This exclusion has been purposive, as I have used a quantitative approach. The focus has been on why some parties might be associated with lower levels of emissions and if this is the case at the local level in Norway. The causal mechanisms between political party presence and emissions levels have been treated as a black box. When finding relationships between specific political parties and emissions, these are only correlations. Although panel matching improves causal inference, it still remains an interpretation.

Another issue is that of spill-over effects between the municipalities. The borders between municipalities are more often and more easily crossed than those between countries. Many people work in one municipality, live in another, and visit their friends in yet another municipality. For example, some municipalities have waste handling facilities that handle the waste of other municipalities. To treat municipalities as acting in a vacuum is therefore artificial and might entail losing out on interesting patterns.

The analysis of GHG emissions will only be as good and precise as the data employed. Although the data on emissions gathered by Miljødirektoratet fulfill the UN standards for calculating emissions, it might be less representative at the local level. Miljødirektoratet calculate some of the emissions using distribution keys, which might not always be accurately distributed, making measuring the effect locally difficult. This is especially true for small municipalities, and some effects might therefore be lost.

Moreover, emissions caused by Norwegian consumption but happening abroad are not included in the data. This makes it impossible to say anything about the total ecological footprint of the municipalities. This is a methodological limit in a lot of research on emissions (Rosa and Dietz 2012, 582). Moreover, the data does not cover off-shore oil and gas production.

The data covers a relatively short time period. It is not sure that one would find the same results for another time period. Therefore, the results cannot necessarily be used to make inferences about the future performance of political parties regarding emissions reductions. Moreover, the data only covers one country making it difficult to generalize the findings to the parties from the same party family in other countries.

Other limitations might be due to model specifications. As the level of emissions is an outcome variable that is affected by a large number of things, including all variables that might affect it is virtually impossible. Not controlling for relevant variables can result in omitted variable bias, which might result in the model attributing the effect of missing variables to those included. As mentioned previously, one specific problem is to discern the effect of voters from the effect of politicians, which cannot be completely controlled for. There are many individual- and society-level variables not included in the model, which might affect both the independent and dependent variables. The relationships might, therefore, be spurious.

8.2 Further research

The findings and limitations presented open several interesting and important pathways for future research. Several different types of research designs could be used to investigate this topic, and various measures could be used as outcome variables. Although using emissions as the dependent variable has some clear advantages, using mitigation policies as a dependent variable could also give important insights. It would also be easier to connect the different parties to policies rather than emissions levels and, thus, easier to make causal inferences.

The fact that there seems to be an effect of political parties, and the Green and Red Party especially, indicates that policy decisions at the local level do matter for reducing emissions. It would be interesting to investigate further which policies are effective. Quantitative analyses of the effect of different policies on emissions would "make the black box smaller," meaning that we would know more about *how* political parties can affect emissions.

Qualitative studies investigating the causal mechanisms between political parties and reductions in emissions would also be very welcome. Knowing more about *how* local politicians have reduced emissions would complement quantitative analyses like the one I have performed in this thesis. The interaction between politicians and the public is an interesting sub-topic to investigate using a qualitative approach, especially how politicians balance the importance of public support and efficiency in climate change mitigation.

Additionally, the sample should also be expanded to include more countries than Norway. This could give insight into whether the findings are specific to Norway or if some party families generally tend to perform better than others regarding local level emission reductions. Comparisons between countries would also be useful in order to figure out whether the local political level needs to possess certain qualities in order to affect emissions.

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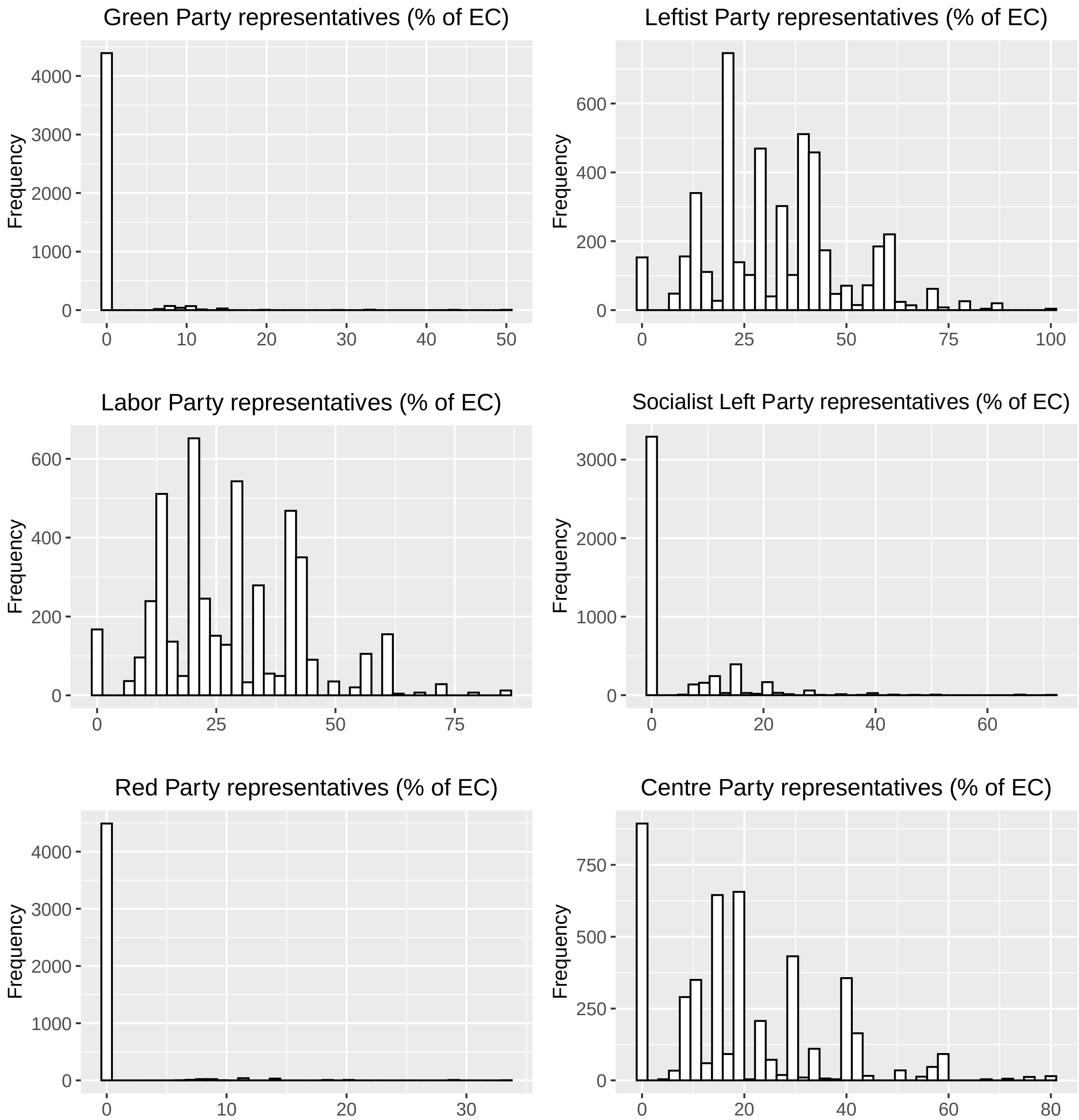
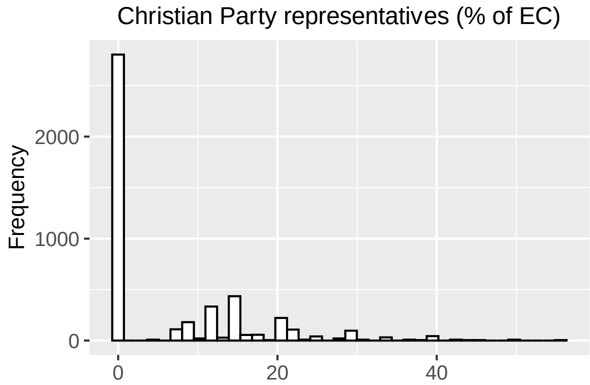
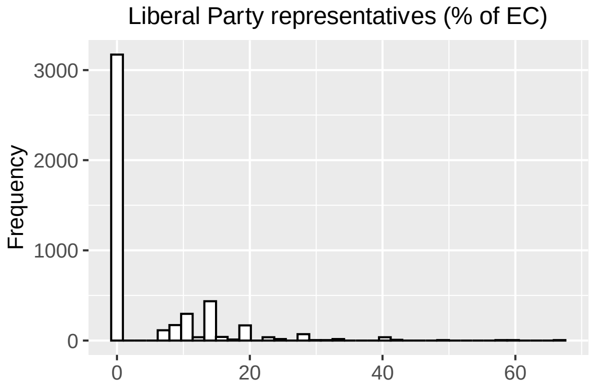
Appendix

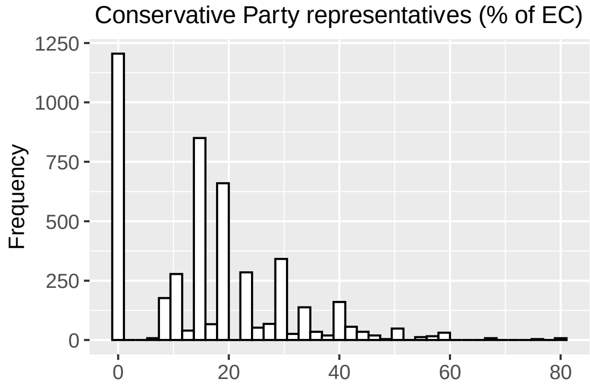
Appendix A: Distributions of variables

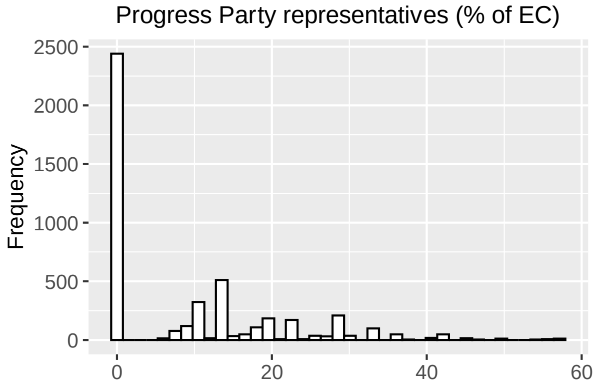
Appendix figure A.1 Distribution of independent variables

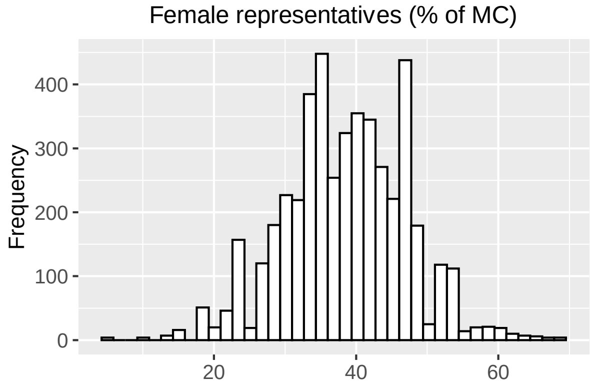


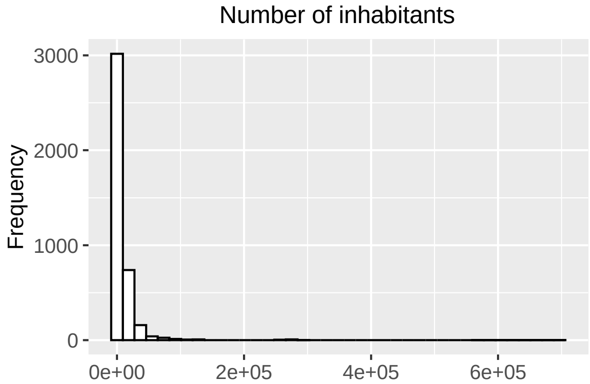

Christian Party representatives (% of EC)
Frequency
0
1000
2000
0
20
40

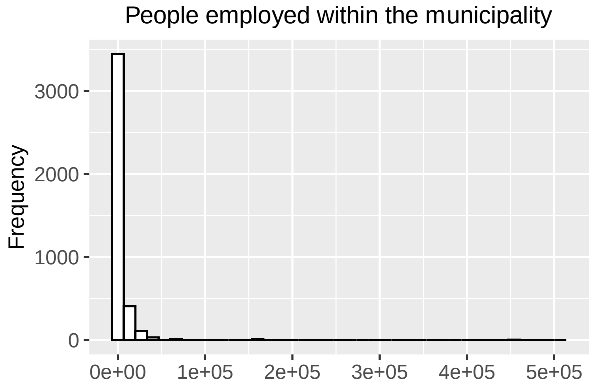

Liberal Party representatives (% of EC)
Frequency
0
1000
2000
3000
0
20
40
60

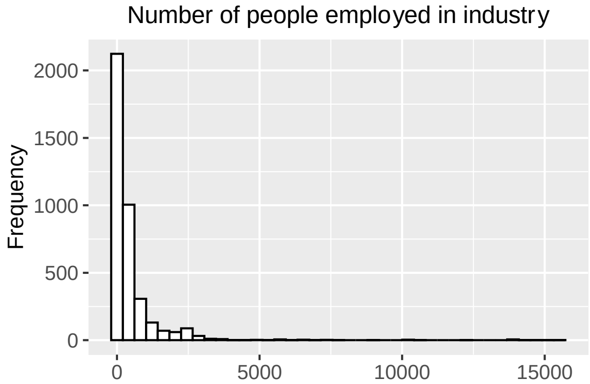

Conservative Party representatives (% of EC)
Frequency
0
250
500
750
1000
1250
0
20
40
60
80


Progress Party representatives (% of EC)
Frequency
0
500
1000
1500
2000
2500
0
20
40
60

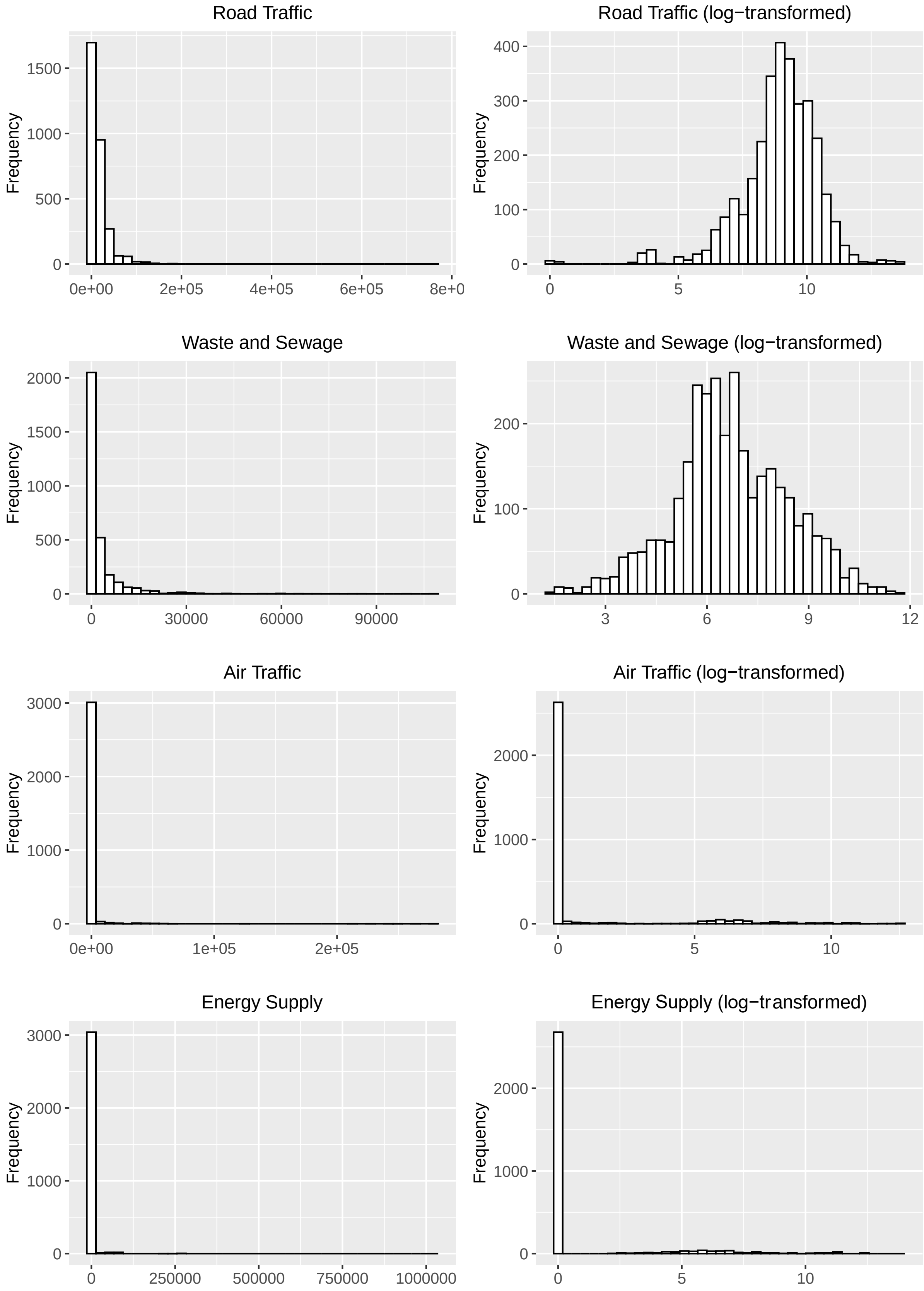

Female representatives (% of MC)
Frequency
0
100
200
300
400
20
40
60

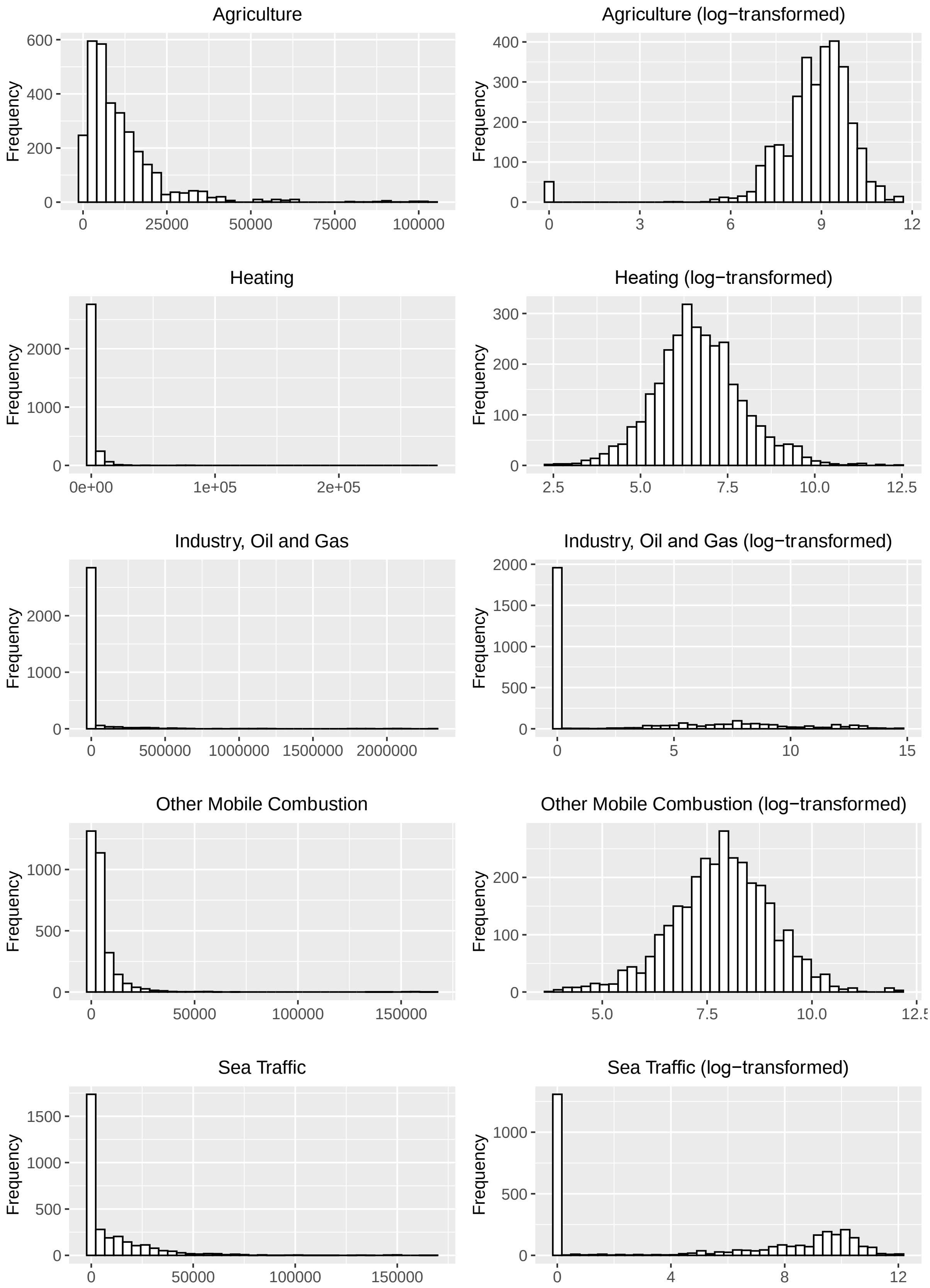

Number of inhabitants
Frequency
0
1000
2000
3000
0e+00
2e+05
4e+05
6e+05


People employed within the municipality
Frequency
0
1000
2000
3000
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05


Number of people employed in industry
Frequency
0
500
1000
1500
2000
0
5000
10000
15000

Appendix figure A.2 Distribution of sector emissions (un-transformed and transformed)




Agriculture
Agriculture (log−transformed)
Heating
Heating (log−transformed)
Industry, Oil and Gas
Industry, Oil and Gas (log−transformed)
Other Mobile Combustion
Other Mobile Combustion (log−transformed)
Sea Traffic
Sea Traffic (log−transformed)
Frequency
0 25000 50000 75000 100000
0 3 6 9 12
0e+00 1e+05 2e+05
2.5 5.0 7.5 10.0 12.5
0 500000 1000000 1500000 2000000
0 5 10 15
0 50000 100000 150000
0 4 8 12

Appendix B: Regression analysis

Appendix table B.1 Fixed effects regression results without merged municipalities

	No lags		*1 year lag*		*2 year lag*	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Green Party	-0.0012	-0.0013 *	-0.0009	-0.0011	-0.0012	-0.0014 *
Leftist parties		0.0002		0.0001		0.0005
Labor Party	0.0002		0.0003		0.0007 **	
Red Party	-0.0025 **		-0.0032 ***		-0.0029 **	
Socialist Left Party	0.0002		-0.0001		-0.0001	
Centre Party	-0.0006 *	-0.0006 *	-0.0010 ***	-0.0010 ***	-0.0006 *	-0.0007 *
Progress Party	0.0008 **	0.0009 **	0.0002	0.0002	-0.0002	-0.0002
Conservatives	0.0005	0.0005	0.0000	-0.0000	-0.0003	-0.0003
Christian Democrats	0.0010 **	0.0011 **	0.0004	0.0004	-0.0002	-0.0002
Liberal Party	0.0005	0.0005	0.0001	0.0000	-0.0003	-0.0003
Female representatives	-0.0003	-0.0004	-0.0003	-0.0003	-0.0003	-0.0004
Inhabitants	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***	-0.0000 ***
Employment	0.0000 **	0.0000 **	0.0000 **	0.0000 ***	0.0000 **	0.0000 **
Employed in industry	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***
Obs.	2951	2951	2951	2951	2951	2951
R^2 / R^2 adjusted	0.070 / -0.044	0.066 / -0.047	0.063 / -0.052	0.058 / -0.057	0.063 / -0.052	0.056 / -0.059

Note: *The dependent variable is the natural logarithm of the total emissions.*
** p<0.05 ** p<0.01 *** p<0.001*

Appendix table B.2 Random effects regression results without merged municipalities

	No lags		*1 year lag*		*2 year lag*	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Green Party	-0.0016 *	-0.0015 *	-0.0014 *	-0.0012	-0.0016 *	-0.0014 *
Leftist parties	0.0003		0.0003		0.0007 *	
Labor Party		0.0004		0.0004		0.0009 **
Red Party		-0.0021 *		-0.0030 **		-0.0027 **
Socialist Left Party		0.0002		-0.0000		-0.0000
Centre Party	-0.0005	-0.0005	-0.0009 **	-0.0008 **	-0.0005	-0.0005
Progress Party	0.0012 ***	0.0011 ***	0.0006	0.0006	0.0001	0.0001
Conservatives	0.0007 **	0.0007 **	0.0002	0.0002	-0.0001	-0.0001
Christian Democrats	0.0013 ***	0.0013 ***	0.0007	0.0007	0.0001	0.0001
Liberal Party	0.0007 *	0.0007 *	0.0002	0.0002	-0.0001	-0.0001
Female representatives	-0.0004	-0.0003	-0.0003	-0.0002	-0.0004	-0.0003
Inhabitants	0.0000	0.0000	-0.0000	-0.0000	-0.0000	-0.0000
Employment	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Employed in industry	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***	0.0001 ***
Obs.	2951	2951	2951	2951	2951	2951
R^2 / R^2 adjusted	0.060 / 0.057	0.062 / 0.058	0.050 / 0.047	0.055 / 0.050	0.046 / 0.043	0.052 / 0.048

Note: *The dependent variable is the natural logarithm of the total emissions.*

** p<0.05 ** p<0.01 *** p<0.001*

Appendix table B.3 Fixed effects regression results for the different sectors without merged municipalities

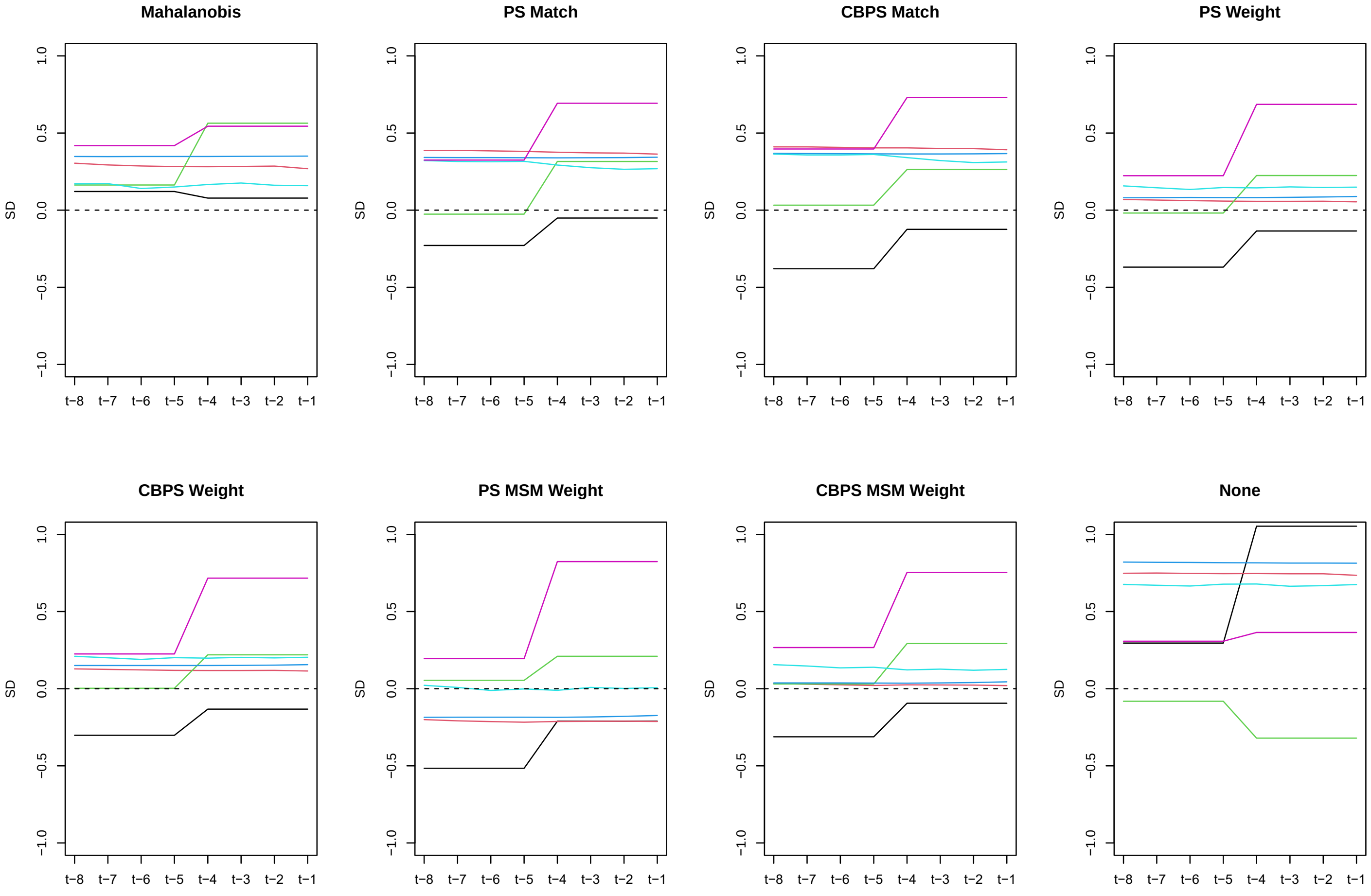
	Road Traffic	Waste and Sewage	Air Traffic	Energy supply	Agriculture	Heating	Industry, oil and gas	Other mobile combustion	Sea Traffic
Green Party	-0.0047 ***	-0.0042 *	-0.0041 *	0.0207 **	-0.0019	-0.0158 ***	-0.0071	0.0018	0.0154 ***
Labor Party	0.0018 ***	0.0039 ***	0.0005	0.0033	-0.0005	0.0053 ***	-0.0022	-0.0015	0.0008
Socialist Left Party	-0.0058 ***	-0.0101 ***	-0.0087 **	0.0635 ***	0.0070 *	-0.0364 ***	-0.0006	0.0010	0.0060
Red Party	-0.0005	0.0020 *	-0.0006	0.0010	0.0000	-0.0016	-0.0019	-0.0009	0.0016
Centre Party	-0.0013 ***	0.0002	-0.0001	0.0025	0.0001	-0.0057 ***	0.0022	-0.0012	0.0021
Progress Party	-0.0008 **	-0.0010	0.0001	0.0101 **	0.0011	-0.0061 ***	-0.0038	-0.0005	0.0010
Conservatives	-0.0012 ***	-0.0011	-0.0005	0.0029	-0.0001	-0.0078 ***	-0.0037	0.0002	0.0020
Christian Democrats	-0.0011 ***	0.0010	-0.0007	0.0068	-0.0013	-0.0044 **	0.0028	-0.0021 *	-0.0000
Liberal Party	-0.0008 **	-0.0005	0.0006	0.0056	-0.0005	-0.0040 **	-0.0032	-0.0004	0.0030
Female representatives	-0.0021 ***	-0.0016 *	-0.0030 ***	-0.0055	-0.0002	-0.0072 ***	0.0065	0.0026 ***	-0.0006
Inhabitants	-0.0000 ***	-0.0000	-0.0000	-0.0000	0.0000	-0.0000 ***	-0.0000	0.0000 *	0.0000
Employment	0.0000 ***	-0.0000	0.0000	0.0001 *	-0.0000	0.0000 **	0.0001	-0.0000	-0.0000
Industry	0.0001 ***	0.0002 ***	-0.0000	-0.0003 *	-0.0000	0.0003 ***	0.0007 **	0.0000	0.0000
Obs.	2951	2951	2951	2951	2951	2951	2951	2951	2951
R^2 / R^2 adjusted	0.252 / 0.160	0.056 / -0.059	0.018 / -0.102	0.023 / -0.097	0.005 / -0.117	0.219 / 0.123	0.012 / -0.109	0.012 / -0.109	0.013 / -0.108

Note: *The dependent variable is the log-transformed emissions from each sector. The political variables (parties and female representatives) are lagged 2 years.*

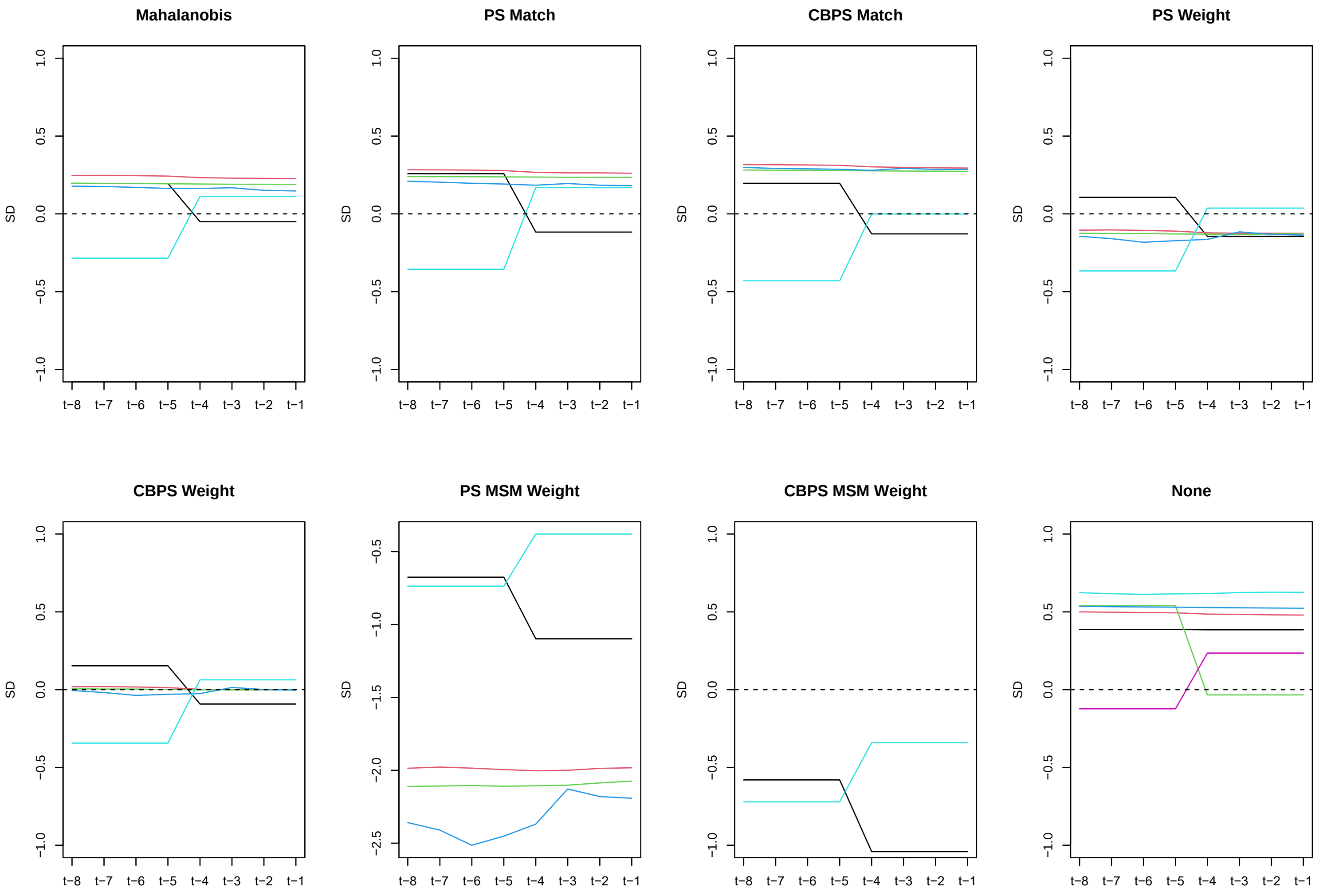
** p<0.05 ** p<0.01 *** p<0.001*

Appendix C: Panel matching

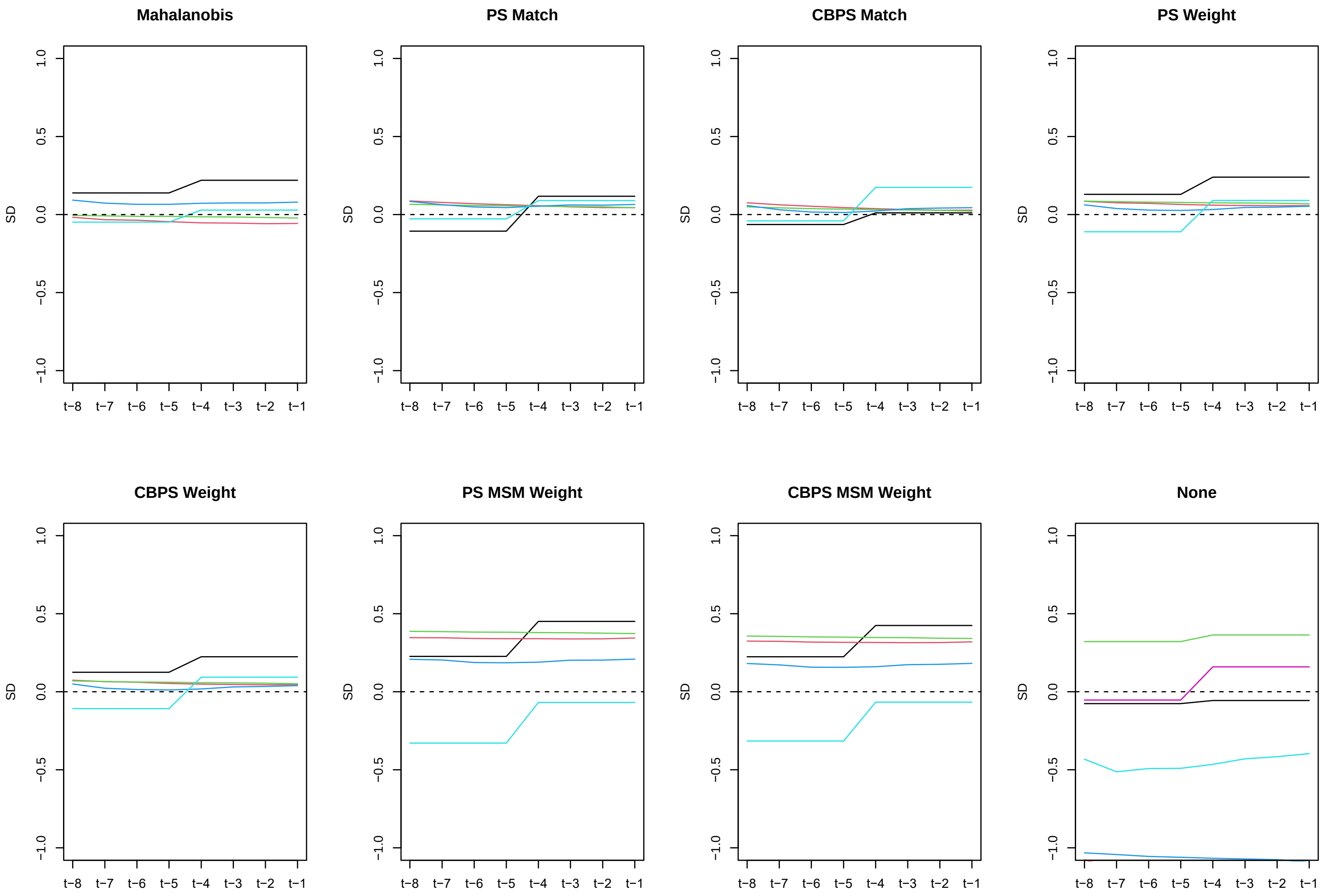
Appendix figure A.1 Treatment = Green Party presence. Covariate balance for the different refinement methods



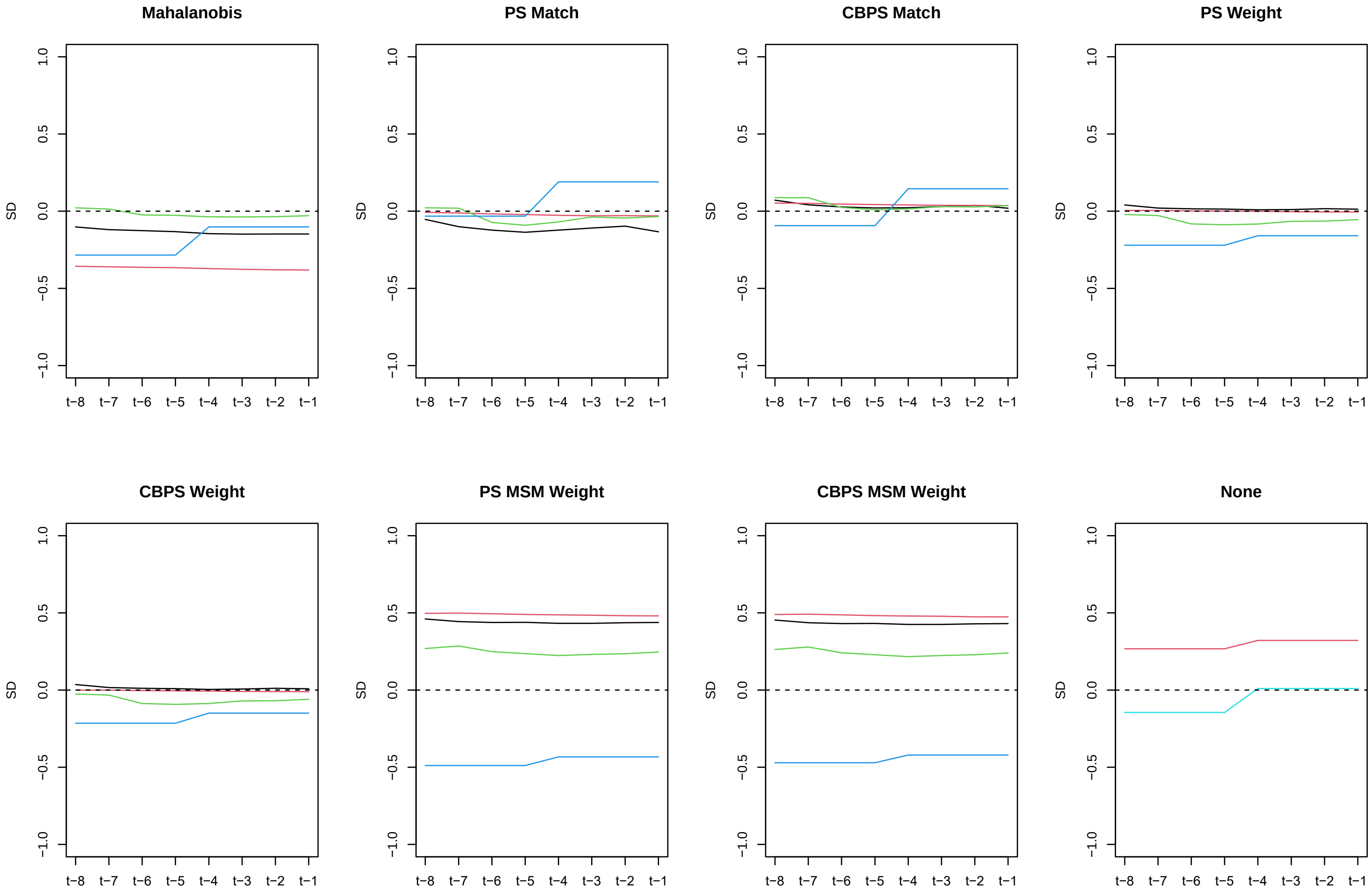
Appendix figure A.2 Treatment = Red Party presence. Covariate balance for the different refinement methods



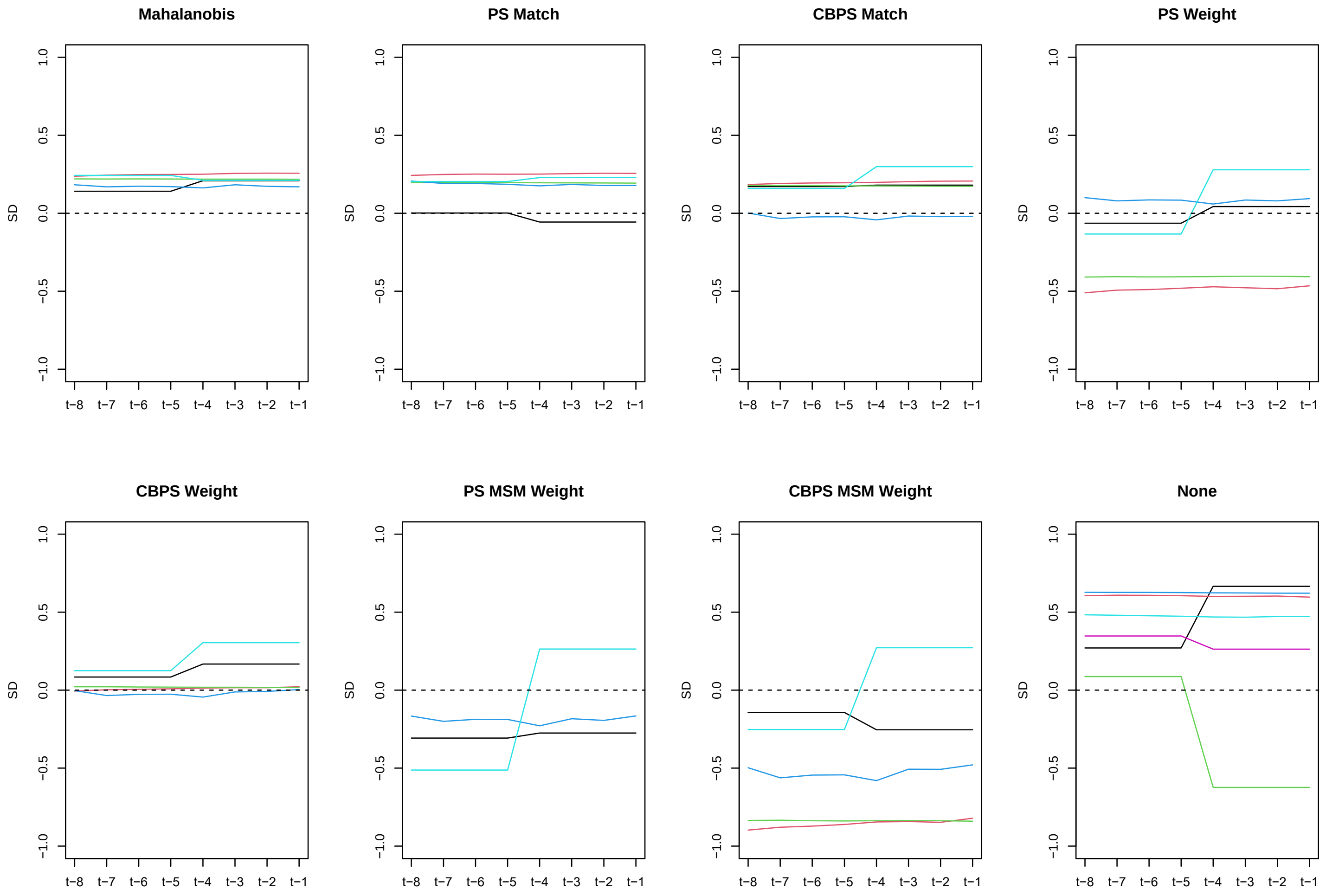
Appendix figure A.3 Treatment = Leftist parties majority. Covariate balance for the different refinement methods



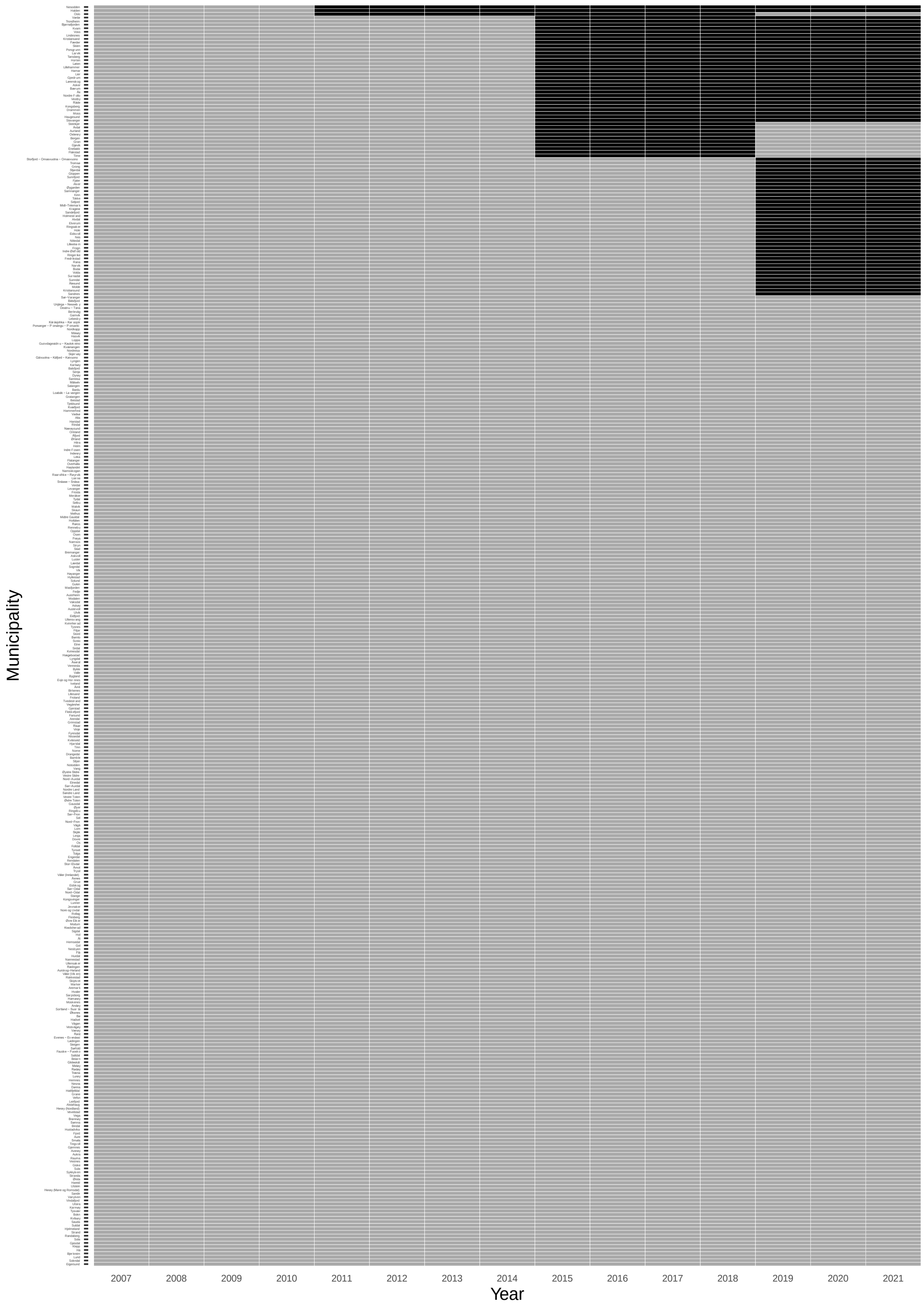
Appendix figure A.4 Treatment = Labor Party majority. Covariate balance for the different refinement methods



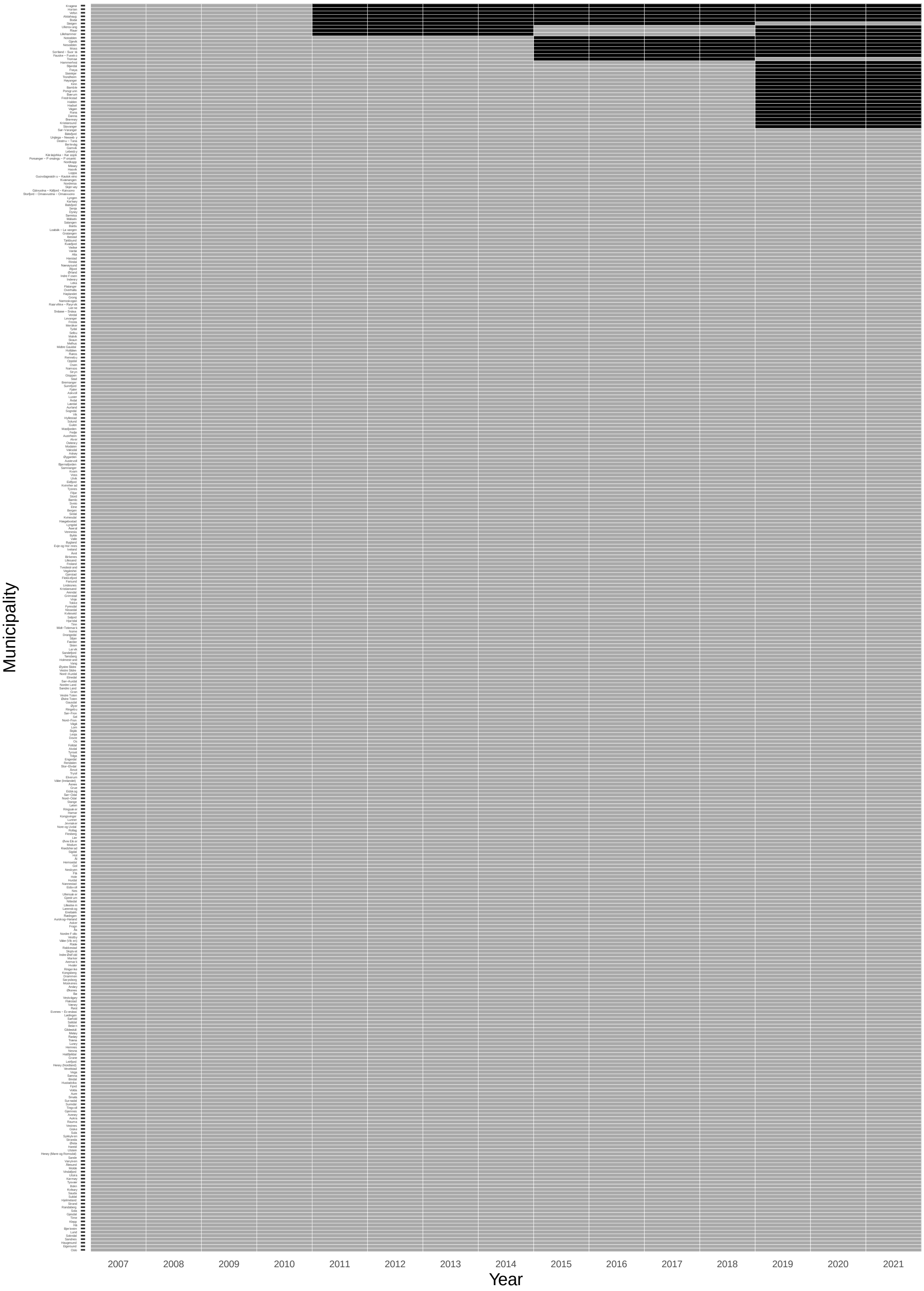
Appendix figure A.5 Treatment = Socialist Left Party. Covariate balance for the different refinement methods



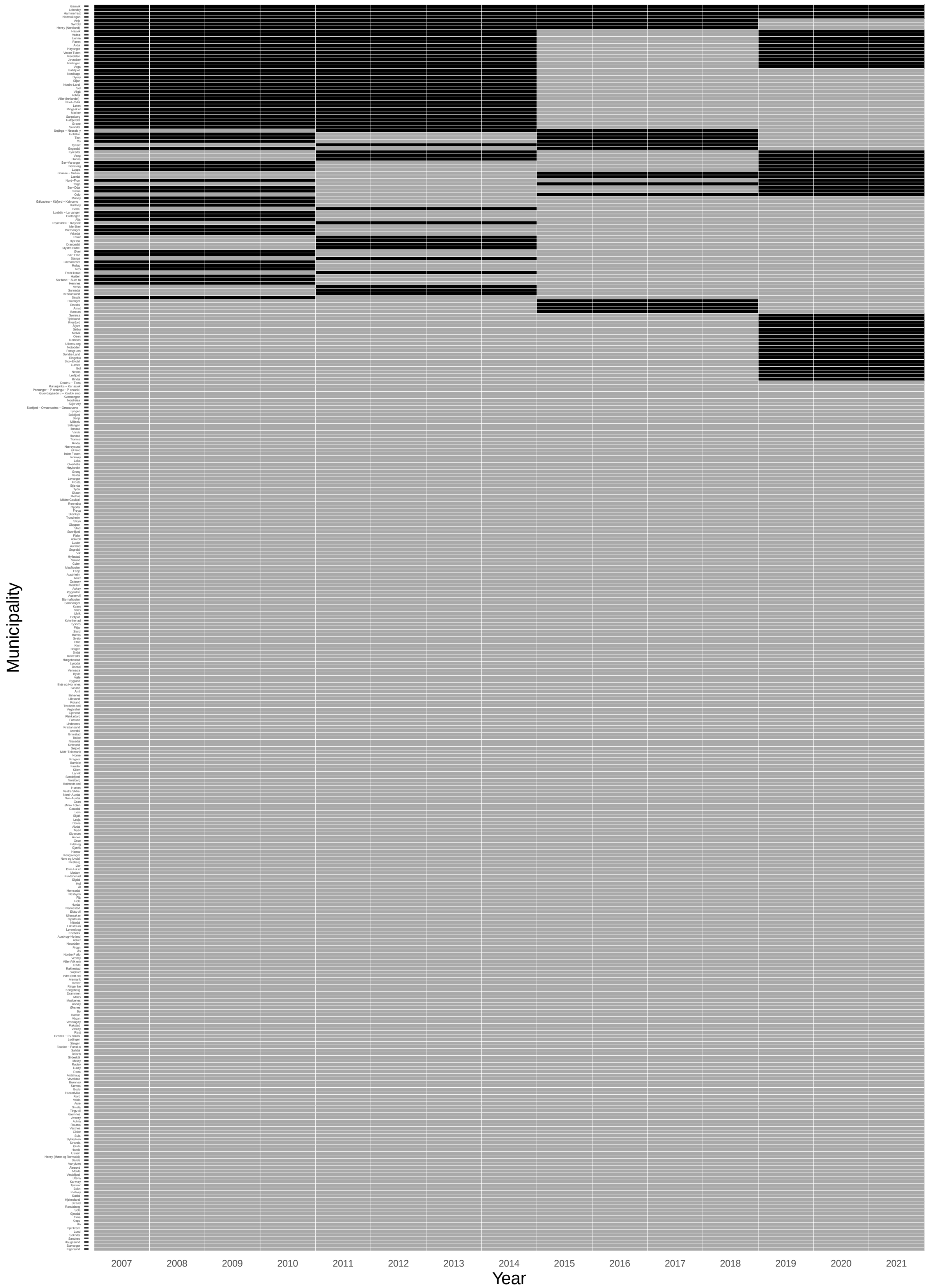
Appendix figure A.6 Municipalities with Green Party presence in the EC shown in black



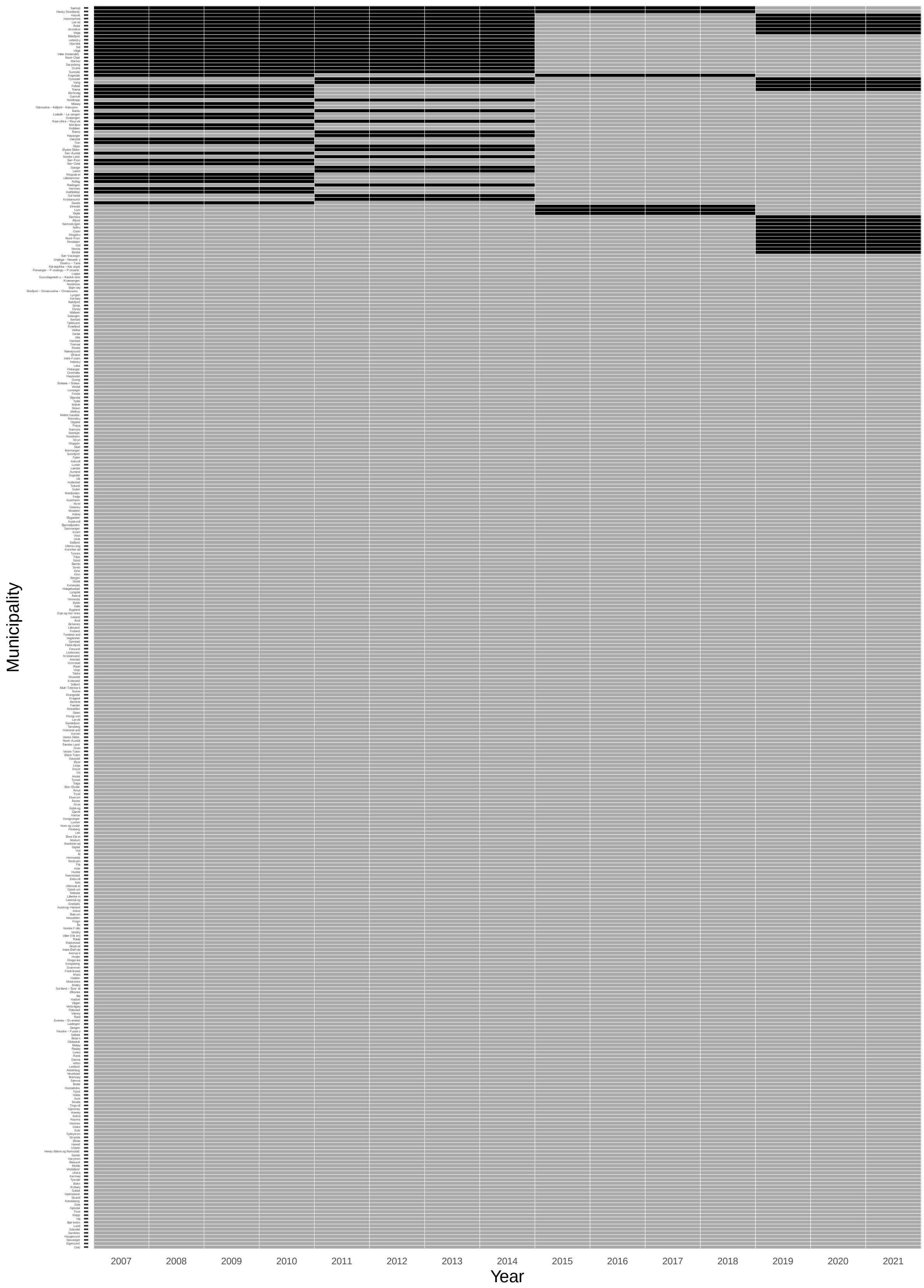
Appendix figure A.7 Municipalities with Red Party presence in EC shown in black



Appendix figure A.8 Municipalities with leftist parties majority in EC shown in black



Appendix figure A.9 Municipalities with Labor party majority in EC shown in black



Appendix figure A.10 Municipalities with Socialist Left Party presence in EC shown in black