MUNICIPAL VOLUNTARY ENVIRONMENTAL PROGRAMS: THE CASE OF SWEDISH ECO-MUNICIPALITIES

by

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ABSTRACT

NATHAN N. DUMA. Municipal Voluntary Environmental Programs: The case of Swedish Eco-Municipalities. (Under the direction of DR. ISABELLE NILSSON)

Over the space of three articles, we attempt to answer two broad questions related to public sector voluntary environmental programs (VEP) through a case study on the National Association of Swedish Eco-municipalities (SEKOM). The first question asks what are the municipal factors that influence the decision to participate in the program. The second set of questions has to do with whether participation in SEKOM improves the environmental performance of members.

In article 1, we consider the factors that influence the eco-municipality participation decision and find that even after accounting for spatial dependence; environmental consciousness, municipality type (urban/suburban/rural), the level of education, industry structure, and environmental vulnerability (as proxied by proximity to the coast) are significant determinants of the municipality's decision to participate in the program.

Article two attempts to determine whether SEKOM improves municipal environmental performance as measured by two environmental policy performance measures: the adoption of environmentally classified vehicles (ECVs) and the implementation of food waste collection policies by Swedish local governments. We make use of a two-stage estimation procedure to account to the self-selection bias that plagues most VEP studies. Our results suggest that SEKOM membership is associated with an increased adoption of ECVs and a higher likelihood of implementing a food waste collection program.

Article three examines the effect of SEKOM membership on the adoption of wind power in Sweden. We make use of a difference-in-difference design with a matched control group. Our

results regarding the existence of a positive and significant overall effect are negative. However, we have evidence of the presence of cohort specific effects. Specifically, these suggest that the length of exposure to the program matters for the magnitude and significance of the effect. Eco-municipalities that joined in the earliest cohorts in our sample had the only significant improvement in both the number of wind power projects and the operational installed capacity.

The primary contribution of this study is to provide a detailed view of a regional public sector voluntary environmental program (VEP) that takes a systems level bottom-up participatory decision-making approach to sustainability. We demonstrate that factors such as environmental consciousness, environmental vulnerability, and the institutional capabilities of the municipalities are significant determinants of the decision to participate in SEKOM. In addition, our results suggest SEKOM membership does improve municipal environmental performance for some measures (food waste policy, and the adoption of ECVs) but not others (wind power adoption). This suggests that it is more difficult to *move the needle* for some environmental issues than others.

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LIST OF ABBREVIATIONS

Acronym	Official Name
AVKT	Average Vehicle Kilometers Travelled
BEV	Battery Electric Vehicle
ECV	Environmentally Classified Vehicles
EMS	Environmental Management System
GHG	Green House Gas
ISO	International Organization for Standardization
NIAW	National Interest Area for Wind Power
OECD	Organization for Economic Cooperation and Development
RES-E	Renewable Energy Sources
SEK	Swedish Krona
SEKOM	The National Association of Swedish Eco-municipalities
U.S. EPA	U.S. Environmental Protection Agency
VEP	Voluntary Environmental Program
VEA	Voluntary Environmental Agreement

INTRODUCTION

This study will consider Sweden's Eco-municipalities as an instance of a public voluntary environmental program (VEP)/green club. Eco-municipalities are local governments that have adopted ecological and social justice values as part of their charter. They differ in structure and orientation from other public sector VEPs in that, instead of focusing on a narrow set of goals, the eco-municipalities take a systems level (across the board) approach to sustainable practices. Their intent is to evaluate all the major actions of the municipality with sustainability in mind (American Planning Association, 2000; James & Lahti, 2004b).

Voluntary Environmental Programs (VEPs) are organizations that attempt to improve the performance of their participants beyond regulatory requirements. These programs can be initiated/sponsored by regulatory agencies (e.g., EPA's 33/50 program), industry associations (e.g., the American Chemistry Council's Responsible Care program), and even non-profits (e.g., ISO14001, SEKOM). In the last few decades these have grown in popularity as an alternative to traditional regulatory instruments such as command and control (Karamanos, 2001; U.S. EPA, 2010). While these have mostly been studied in the context of regulator sponsored VEPs for the private sector, there is a growing literature on public sector programs for local governments (Hughes, 2012; Ko & Prakash, 2022).

Voluntary programs have the following characteristics: First, they are completely voluntary meaning that there are no penalties for not joining and the agreements are not legally binding. Second, their objective is to improve environmental conditions. Third, they are based on some agreement either formal or informal. The final feature is that they are formed between/within various sectors (government, corporate, non-profits) (Karamanos, 2001)[1]. Most of the early

[1] In this study the terms Voluntary Environmental Program (VEP), and Green Club are used interchangeably.

research on voluntary programs examined their use to promote positive environmental outcomes in the private sector (Potoski & Prakash, 2005). The more recent literature has started to consider the involvement of local governments in such programs as part of attempts to improve their environmental performance over and above the goals set by the national government.

A lot of this new strand of literature has focused on transnational environmental networks examples of which include the Cities for Climate Protection (CCP) and the Global Covenant of Mayors for Climate and Energy (COM) (Betsill & Bulkeley, 2004; Dolšak & Prakash, 2017; Heikkinen et al., 2020). Both are global networks of cities and local governments collaborating on climate issues. These programs are instances of transnational collective action targeted at subnational actors, and because participation is non-mandatory and any commitment to join is not legally binding; they fit the definition of voluntary environmental programs/green clubs. They differ from the National Association of Swedish Eco-municipalities (SEKOM) in that they are transnational instead of regional, they have a much narrower focus, and they do not explicitly emphasize the bottom-up participatory decision-making approach of SEKOM.

VEPs are distinct from "*Climate Clubs*", which are a related concept proposed by Nordhaus (2015). In Climate Clubs the participants are countries which voluntarily join the program whose goal is to overcome freeriding in international climate policy by imposing sanctions on non-participants and defectors. As, a result of these sanctions, Climate Clubs are not truly voluntary in the sense implied by Karamanos (2001).

Two studies, one by Cochran (2015) and another by Jones (2016) have examined U.S. environmental schemes such as Renewable Portfolio Standards (RPS), and the Regional Greenhouse Gas Initiative (RGGI). The former consists of a set of policies voluntarily adopted by states to increase the generation of energy from renewable sources in response to the passage of the Energy Policy Act by the federal government in 2005 (Brown, Sovacool, & Hirsh, 2006). The latter is a collaborative effort between 12 U.S. states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia) to reduce CO2 emissions form the energy generation sector. Both programs combine aspects of firm-level VEPs and those of public sector VEPs. They are instances of states voluntarily opting to impose largely mandatory policies on energy producing firms within their boundaries in order to increase the adoption of renewable energy (in the case of RPS) or reduce CO2 emissions (in the case of RGGI). For both programs the participation of states is mandatory but that of the targets of the regulations (utilities) is largely not. In addition, the focus on a single environmental goal stands in sharp contrast to the very general principles of SEKOM.

This dissertation consists of three articles which consider two classes of hypotheses both of which relate to the National Association of Swedish Eco-municipalities (SEKOM).

1) The first class has to do with the reasons why local governments would voluntarily opt to join a VEP such as SEKOM. This is the subject of the first article. We make the argument that municipal attributes such as environmental consciousness, environmental vulnerability, average education level, income, and many others influence the decision to participate in SEKOM by altering the balance of the costs versus benefits of joining SEKOM.
2) The second class of hypotheses has to do with whether SEKOM membership improves the environmental performance of local governments. This class forms the basis for Articles 2 and 3.
    i. In Article 2 which is closely related to Article 1, we hypothesize that SEKOM membership improves environmental performance as measured by

the municipal adoption of Environmentally Classified Vehicles (ECVs) (alternatively known as Green Vehicles). It is related to Article 1 in that we make use of the predicted probability of program participation estimated from Article 1 to control for self-selection bias in Article 2.

ii. In Article 3, we hypothesize that SEKOM membership is associated with a greater adoption of wind power as measured by the number of wind power projects, and the installed capacity in megawatts.

Previous research has largely considered firm level voluntary programs, but local governments can also exhibit "beyond *compliance behavior"* by joining VEPs. Their motivations for joining are likely different from those of private firms. The hypotheses above help us to answer important policy questions about why municipalities may seek to improve their environmental performance beyond the targets set by the national government. Knowing the factors associated with VEP participation may provide insights about how to encourage more local governments to participate. An even more important policy question is whether public sector VEPs serve their purpose and improve environmental performance. If VEPs such as SEKOM are a greenwash that only serves to confer reputational benefits to members without improving their environmental performance, then they have no policy relevance. However, if they do improve environmental performance, it may be a sensible policy action to encourage other municipalities to participate or create similar programs in other countries.

ARTICLE 1: LOCAL FACTORS DRIVING THE ADOPTION OF MUNICIPAL VOLUNTARY ENVIRONMENTAL PROGRAMS: THE CASE OF SWEDEN'S ECO-MUNICIPALITIES

1.1. Introduction

The set of policy tools that governments in the developed world have at their disposal to achieve positive environmental outcomes has grown considerably over the last few decades. Prior to the 1980s, regulators relied heavily on command-and-control regulations, over time these came under heavy criticism for contributing to an adversarial regulatory culture. The view has shifted toward perceiving the tools of traditional regulation as inflexible, politically unpopular, and economically inefficient because of high enforcement costs. Starting in the 1990s, nonregulatory approaches (voluntary alternatives) have gained traction as viable alternatives to more traditional regulation (Karamanos, 2001; U.S. EPA, 2010).

Voluntary programs such as these have proved to be popular mainly because they have greater political traction than traditional regulation. As of 2005 the U.S. EPA alone had more than 87 voluntary programs (U.S. EPA, 2005). These voluntary initiatives are variously referred to in the literature as: voluntary remediation programs, green clubs, voluntary environmental agreements (VEAs), public voluntary programs, and voluntary environmental programs (VEPs). They have been studied mostly in the context of regulator and industry association sponsored programs where firms are the participants. There has been comparatively less work examining the use of such programs in the public sector (Hughes, 2012).

Most of the early research on voluntary programs examined their use to promote positive environmental outcomes in the private sector (Potoski & Prakash, 2005). The firm-level literature has attempted to answer questions relating to the motivations of private firms in joining VEPs

(DeCanio & Watkins, 1998; Khanna & Damon, 1999), and whether voluntary programs actually improve environmental outcomes (Koehler, 2007; Morgenstern & Pizer, 2007). The more recent literature has started to consider the involvement in local governments in such programs as part of attempts to improve their environmental performance over and above the goals set by the national government.

A lot of this new strand in the literature has focused on transnational environmental networks examples of which include the Cities for Climate Protection (CCP) and the Global Covenant of Mayors for Climate and Energy (COM) (Betsill & Bulkeley, 2004; Dolšak & Prakash, 2017; Heikkinen et al., 2020). Both are global networks of cities and local governments collaborating on climate issues. These programs are instances of transnational collective action targeted at subnational actors, and because participation is non-mandatory and any commitment to join is not legally binding; they fit the definition of voluntary environmental programs/green clubs.

This paper will consider Sweden's Eco-municipalities as an instance of a national-level public voluntary environmental program (VEP), or green club, and examine which factors are influential in determining which municipalities choose to participate. Their reasons for participation in VEPs differ from those of private firms and depend on municipality specific factors. Eco-municipalities are local governments that have adopted ecological and social justice values as part of their charter. These municipalities take a systems level (across the board) approach to sustainable practices. For our purposes, a municipality will be considered to be an eco-municipality if it is a member of the National Association of Swedish Eco-municipalities (SEKOM).

Our results suggest that environmental consciousness (as proxied by share of votes for the Green Party), level of education, the municipality being suburban, and environmental vulnerability (as proxied by proximity to the coast) are positively associated with program membership. The employment share in heavy industry was negatively associated with program membership. Other municipal attributes such as average age, population, average household income, and foreign-born residents turned out to insignificant in explaining membership in SEKOM. As expected, the effect sizes after controlling for spatial dependence tended to be smaller in magnitude and less significant. We make the argument that municipal attributes affect the likelihood of program participation by altering the balance of costs versus benefits of membership. This argument is developed more fully in Section 1.6.

The remainder of this article is structured as follows: Section 1.1.2 provides a background on Swedish Eco-Municipalities. Section 1.1.3 reviews the literature on factors driving adoption of VEPs. The data and empirical approach used in this article are described in Section 1.1.4 while results are presented in Section 1.1.5. Concluding remarks are provided in Section 1.1.6.

1.2. Background: Sweden's Eco-Municipalities

An Eco-municipality is a local government that has officially adopted a specific set of sustainability principles as part of its charter including a commitment to a bottom-up, participatory approach for implementing those principles. The first eco-municipalities developed in Sweden started with the city of Övertorneå in 1983. The concept has since spread to places as far afield as Ethiopia, Canada, and the United States. The Rio Declaration on Environment and Development (Agenda 21) created and adopted at the 1992 U.N. World Conference on Sustainable Development was modelled on the pioneering work of early eco-municipalities. At the turn of the millennium, the American Planning Association adopted the Planning for Sustainability Policy Guide which is based on the same sustainability principles as Swedish Eco-municipalities (American Planning Association, 2000; James & Lahti, 2004b).

In 1995, 20 Swedish municipalities came together to form the National Association of Swedish Eco-municipalities (SEKOM). Their goal in joining together was to share resources and knowledge instead of developing them in-house, and work for sustainable change beginning at the local level. The number has since grown to 101 municipalities which make up close to a third of Sweden's 290 municipalities. Today, no less than 42% of Sweden's population lives in an eco-municipality. What distinguishes the eco-municipality approach from other voluntary environmental initiatives is that it is an across-the-board systematic approach to changing sustainable practices[2]. Unlike other VEPs, the approach does not focus on a single-issue area but rather attempts to improve a broad range of environmental outcomes based on a set of four principles.

Eco-municipalities have educated thousands of their public employees about unsustainable environmental and social practices and how ecological/green innovations can be adapted to the local context in order reduce their impact. The planning process is bottom-up and attempts to engage the community to find ways to reduce the use of fossil fuels, encroachment on nature and to meet human needs while minimizing negative impacts on the environment. Perhaps more than anything else, eco-municipalities are a network that closely resembles Prakash and Potoski's (2006) notion of a green club. Through conferences and SEKOM's quarterly publications,

[2] Adopting the definition set out in the UN report Our Common Future of 1987 we take sustainable development to mean, "*Development that satisfies today's needs without jeopardizing the ability of future generations to satisfy their needs*."

municipalities get to learn from their peers about the latest approaches to sustainability. The annual reporting requirements on environmental outcomes serve as a form of social control.

To join SEKOM, municipalities must pass a resolution adopting the guiding principles and then apply for membership. In their book, *The Natural Step for Communities* James and Lahti (2004a) describe the eco-municipality concept and outline the main guiding principles. The guiding principles are summarized below:

- Reduce dependence on fossil fuels.
- Reduce dependence on synthetic chemicals e.g., agriculture.
- Reduce encroachment on nature e.g., waste, forests, wildlife, ecosystems.
- Meet human needs fairly and efficiently e.g., participatory planning and decision making.

These principles are very general and encompass a large number of environmental outcomes. describe some of the initiatives conducted by the eco-municipalities. These include adopting renewable energy sources for winter heating, using electric vehicles for public transport, ecological housing, sustainable (organic) agriculture, and waste recycling initiatives. These were all initiatives that originated from a few municipalities and spread through the SEKOM network.

Figure 1-1 below shows which municipalities were part of the eco-municipality network in 2020. An estimated 42% of Sweden’s population live in an eco-municipality.

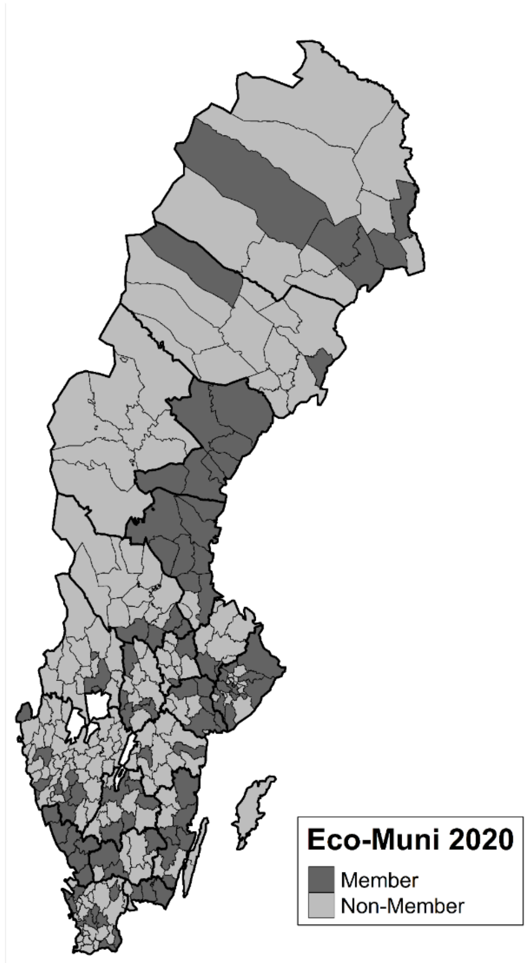

Figure 1-1: SEKOM members in 2020

Counties are the largest geographic subdivision in Sweden. There are 21 counties, and these are denoted using the bold boundaries in Figure 1-1. Municipalities are a subset of counties, there are 290 municipalities, and these are denoted using the lighter boundaries in Figure 1-1. Each municipality has an elected body (municipal council) that makes decisions on municipal matters.

Sweden's municipalities have the authority to make wide range of decisions, a lot of which relate to the environment. As we have already mentioned, the decision to become an eco-municipality is made based on a resolution passed by the municipal government. In addition, municipal decision makers have the power to veto any decision to establish local wind power (Ek, Persson, Johansson, & Waldo, 2013), to design and implement recycling and waste management policy (Ek & Miliute-Plepiene, 2018), and to influence the adoption of electric vehicles by both the local government and its residents (Egnér & Trosvik, 2018).

1.3. Related Literature

Voluntary Environmental Programs (VEPs) have been used by governments and regulators as a nonregulatory approach to induce beyond compliance behavior by firms. They have been touted for their flexibility, low cost, and economic efficiency (Morgenstern & Pizer, 2007). VEPs have been used to try to address a wide variety of environmental issues including air, water and land pollution, energy efficiency, natural resource management and biodiversity protection. In this section our goals are to: Precisely define what we mean by voluntary programs, and then make use of existing theoretical/empirical perspectives to motivate our hypotheses for why municipalities choose to join SEKOM.

1.3.1. Defining Voluntary Environmental Programs

A natural place to start would be by defining precisely what we mean by voluntary environmental program. This is especially important as these programs are widely varied and many names have been used to describe them. Hughes (2012) noted that voluntary initiatives take on many names some of which include: voluntary remediation programs, green clubs, voluntary environmental agreements (VEAs), public voluntary programs, and voluntary environmental programs (VEPs).

VEPs can be sponsored by a diverse set of actors including but not limited to government agencies (e.g., EPA's 33/50 program), industry and trade associations[3], and independent third parties such as non-profits (e.g., ISO14001). Sponsors bear the responsibilities and costs of designing the program, recruiting participants, and monitoring compliance (Prakash & Potoski, 2012).

Following Karamanos (2001) we will take a voluntary environmental program to be one that encompasses four defining characteristics:

1. VEPs are voluntary.
    - There are no penalties for not joining.
    - The agreements are not legally binding.
2. The objective is to improve environmental conditions.
3. Based on an agreement either formal or informal.
4. Formed between/within various sectors (government, corporate, non-profits).

Based on these features, we follow Darnall, Potoski, and Prakash (2010) in defining VEPs as: "*Programs, codes, agreements, and commitments that encourage their participants to reduce their environmental impact beyond regulatory requirements. These VEPs can be sponsored by government agencies, industry and trade associations, or independent third parties such as non-profits"* (p. 284).

From this it is clear that SEKOM is a special case of a VEP, specifically one that is sponsored by a non-profit and caters only to public sector entities.

[3] An example of an industry association sponsored VEP is the Responsible Care program sponsored by the American Chemistry Council (formerly The Chemical Manufacturers Association). The program promotes pollution prevention, waste minimization and energy conservation. It has mandatory transparency reporting for its members (Prakash & Potoski, 2006 p.25).

1.3.2 Motivation for Joining Voluntary Environmental Programs

There are a lot of studies that have considered the reasons why private sector entities choose to participate in voluntary environmental programs. Public sector entities such as cities and municipalities may have different motivations for joining as they do not have shareholders and customers to appeal to. However, they do have voters to appeal to and may hence join for signaling value. Several theoretical frameworks have been proposed to explain why firms engage in beyond compliance behaviors such as participating in VEPs. We will explore and attempt to relate these to the public sector case.

In their 2006 book, Prakash & Potoski develop a theory of green clubs based on Buchanan's (1965) economic theory of clubs. According to Buchanan (1965), club goods are impure public goods that have the properties of being non-rival and excludable. Prakash and Potoski (2006) extend this theoretical framework to voluntary environmental programs which they refer to as green clubs. Green clubs exist to produce positive environmental externalities beyond regulatory requirements. Membership costs involve both payments to the program sponsors and the costs of complying with the membership requirements. The excludable benefit that green clubs offer their participants is the goodwill they obtain from their stakeholders for being associated with the club's brand. They argue that environmental actions taken unilaterally are less valuable than those taken collectively under the banner of the club's brand identity.

A study by Hughes (2012) evaluated a voluntary urban water conservation program for local governments in California. The goal of the program was to reduce per capita water consumption in response to drought. Hughes found that the local governments that joined the program did so for more than just the signaling value. Practical considerations relating to the attributes of those public entities were an important predictor of who chose to join the program. Municipalities that were the most vulnerable to drought and were dependent on purchased water supplies were the most likely to join presumably because they had a genuine interest in accessing the benefits of the program (i.e., to conserve water).

Ko and Prakash (2022) found evidence to suggest that membership of voluntary climate clubs provides tangible signaling benefits to U.S. cities. Cities that were part of the International Council for Local Environmental Initiatives (ICLEI), Cities Climate Leadership Group (C40), and 100 Resilient Cities (100RC) programs which focus on climate change and climate adaptation were issued higher ratings for their municipal bonds by S&P, Moody's, and Fitch. By being members of these programs, these municipalities signaled their resilience to climate risks the implication being that they would likely still be in a position to service their municipal bonds in the event of a climate related crisis.

Based on these studies, we argue that municipalities could become eco-municipalities for several reasons. The first reason is to improve their environmental performance. This could be done in response to some source of environmental vulnerability (e.g., drought, coastal proximity). A second reason is to use the reputational benefits associated with membership to signal to their various stakeholders (e.g., voters, employees, potential residents, or even municipal bond holders).

1.3.3 Factors which potentially influence program participation

In this section we will briefly outline some of the factors that we have theoretical and/or empirical reasons to believe can influence the decision to join voluntary environmental programs. Local economies gain from attracting residents into their jurisdictions. In a country where the residents already have a high level of environmental concern, one dimension along which municipalities may compete for constituents is environmental quality. Membership in the eco-municipality association may be a valuable way to signal to potential (as well as existing) residents that the local government cares about and is prepared in invest in the environment. This signaling ability may be more valuable for municipalities that are lagging on more concrete environmental performance measures. A study U.S. study by Wang (2011) found that on average urban municipalities had higher environmental spending. In Sweden, rural municipalities lag behind urban ones on green vehicle adoption and waste management (Egnér & Trosvik, 2018; Ek & Miliute-Plepiene, 2018).

Municipalities with a coastline likely face a wider range of environmental issues. Coastal management is at the confluence of numerous environmental matters from land use management, water use planning, resource management and utilization (i.e., fisheries, gravel mining etc.), coastal erosion, and water pollution from agricultural/industrial runoff (Morf, 2005). Even though floods (especially in coastal areas) are expected to occur more frequently in Sweden because of climate change, there is no national flood risk policy. Coastal management is largely the domain of local government. While this decentralized approach allows decisions to be tailored to local conditions, municipalities may not have sufficient knowledge or financial resources (Ek, Goytia, Pettersson, & Spegel, 2016).

A study by Wang (2011) on various categories of environmental spending by Florida local governments found that counties by the coast tended to spend more on both environmental protection and utilization. In studies measuring climate resilience and environmental vulnerability, proximity to the coast has been used as an input in the models. A study by Zahran et al. (2008) found that proximity to the coast was a significant determinant of the participation of US municipalities in the transnational environmental program, Cities of Climate Protection (CCP).

Another study found that proximity to the coast (in New Zealand) was linked to belief in climate change and that this effect was likely fueled by the perception of increased risk (Milfont et al., 2014). Based on this, we make use of adjacency to the coast as a proxy variable for environmental vulnerability. Municipalities adjacent to the coast need all the help they can get to manage a wide range of environmental issues which would make them more likely to join SEKOM.

Economic base theory from the regional development literature is another useful framework which can be used to think about the factors influencing the decision to join. In brief, economic base theory divides the economy of a region into basic and non-basic sector. Where the basic sector is one that exports goods and services outside the region to increase the wealth of the region (Davis, 1990). Coastal and nature tourism, and fishing constitute a non-trivial proportion of the economic base of Swedish coastal municipalities. This makes it economically beneficial for such municipalities to take steps to preserve the environmental attributes on which these economic activities rely. One such step is to join a VEP such as SEKOM. By the same argument, municipalities whose economic base is heavy industry, would be less likely to join VEPs because actions taken to improve environmental quality may come at an unacceptably high cost.

Rural municipalities are less populous and have a smaller revenue base, this likely means that they do not have the resources to hire specialized staff focused on environmental issues or develop and maintain in-house environmental programs. As a result, it is likely that they have more to gain by joining the SEKOM network. One study which may be relevant for understanding this is by Khanna, Koss, Jones, and Ervin (2007) where they explored the motivations of small firms in joining VEPs. They found that one reason smaller firms joined VEPs was because they did not have the resources to maintain in-house R&D programs to reduce their environmental impacts. Because of this they stood to gain more from the knowledge sharing that resulted from joining.

This made them more likely to join except in cases where the costs of program participation and compliance were very large. Based on this, our expectation is that SEKOM membership will be more valuable to rural municipalities and that they will be more likely to join.

The goal of SEKOM is to improve environmental/sustainability performance, hence it makes sense that municipalities with greater environmental awareness are more likely to decide to become members. In a study on the adoption of electric vehicles by the residents of Swedish municipalities, Egnér and Trosvik (2018) use the share of votes for the Green Party as a proxy for the environmental awareness of a municipality. While environmentally conscious people will not necessarily vote for the Green Party, this proxy is a close enough approximation given that the party's platform heavily revolves around environmental matters. Our expectation is that municipalities with a higher share of votes for the Green Party are more likely to be members.

A variety of institutional factors can also shape the participation of local governments in voluntary environmental initiatives (Fischer & Jager, 2020). Sharp, Daley, and Lynch (2011) investigated factors influencing U.S. municipalities to participate in the ICLEI program. They investigated four classes of institutional factors influencing program participation. The first of these was *Organized interest and civic capacity* which included factors such as the education level of the population and the number of environmental groups in the city. Their hypothesis was that more educated communities and communities with large numbers of environmental groups not only had a higher institutional capacity to mobilize and advocate for environmental improvement, but that they had a greater interest in doing so[4]. As a result, they were more likely to join ICLEI.

[4] Interestingly another study of the transnational Covenant of Mayors program found that the number of environmental NGOs in a country increase the proportion of its population living in a city signed up for the program. This provides additional support for the idea that civic capacity may be important for program participation (see, Dolšak & Prakash, 2017).

Since we do not have data on the number of environmental non-profits in each municipality, we use the percentage of votes for the green party to represent both the level of environmental consciousness and the level of civic capacity. We hypothesize that more educated municipalities and those with a higher vote share for the green party will be more likely to join SEKOM.

The second class of factors was *Oppositional organized interest* which included just a single variable for the contribution of manufacturing to the economy of the city. The argument being that the presence of organized interest groups with a vested interest in opposing membership of a climate group such as ICLEI would put pressure on municipal decision makers not to join. Municipalities that have a large share of their population employed in heavy industry (that results in pollution and other environmental impacts) may be reluctant to join an organization such as SEKOM which has mandatory reporting requirements of various measures of environmental performance. However, we expect that municipalities with more heavy industry are less likely to join SEKOM.

The third factor was *Need or problem severity* which included factors such as population, and fiscal stress. They argued that more populous areas likely faced a wider range of environmental challenges and needed all the help they could get in tackling those challenges. Interestingly fiscal stress made municipalities more likely to join but impeded program implementation. The reason for this is that by joining the program municipalities hoped to benefit from cost savings associated with activities such as retrofitting municipal buildings to be more energy efficient, recovering methene from landfills, replacing traffic lights with LEDs, or replacing municipal vehicles with hybrids (Sharp, Daley, & Lynch, 2011). In our case, variables such as environmental vulnerability (proxied by proximity to the coast), being rural and low income, and having a large population will stand in as institutional factors related to need or problem severity. Our expectation is that low income, rural status, environmental vulnerability, and high population are associated with a higher likelihood of becoming an eco-municipality.

The fourth and final factor had to do with the political institutions or the structure of government in the city. Cities with a greater degree of metropolitan fragmentation (more widely distributed decision making) faced more obstacles in joining the organization. This last factor is not relevant for Sweden where all the municipalities have the same governmental structure.

Socio-economic factors such as age structure will also be included in our models. We expect age to negatively influence program participation. Some studies have suggested that average age is negatively associated with the adoption of new technologies (Caselli & Coleman, 2001; Mersky, Sprei, Samaras, & Qian, 2016). Given that Eco-municipalities are an ecological innovation, we expect the same pattern to persist.

An increasing portion of Sweden's population is foreign born, depending on their country of origin it is plausible that they may not share the postmaterialist values (like environmental concern) that the native-born residents do. Some studies in the U.S. have found lower levels of recycling and environmental concern among foreign-born residents (Hunter, 2000; Johnson, Bowker, & Cordell, 2004). If this pattern can be extrapolated to Sweden, then it is possible that municipal decisionmakers in areas with a large percentage of foreign-born residents may take these preferences into account. We expect that municipalities with a high percentage of foreign-born residents to be less likely to join the eco-municipality association.

Finally, knowledge spillovers may play a role in in the participation decision of municipalities. A study by Häggquist and Nilsson (2017) considered the possibility of knowledge spillovers influencing municipal adoption of geological information in Sweden. There is a rich literature on the diffusion of innovation where studies show that environmental innovations typically have positive spatial spillovers (Xu, Dong, Chen, & Qin, 2021). Based on this, we expect that municipalities whose neighbors are eco-municipalities are themselves more likely to become members.

Table 1-1 outlines the factors that we will consider as well as our a priori expectations of the direction of the association.

Table 1-1: Summary of factors which potentially influence program participation

Variables		**Potential Effects**
% Votes for Green Party	+	Municipalities with a higher vote share for the Green Party are more likely to join
% Post-Secondary Education	+	Municipalities with more educated residents are more likely to join.
% Foreign Born	-	Municipalities with more foreign-born residents are less likely to join.
% Employed in Heavy Industry	-	Municipalities with a high share of employment in heavy industry are less likely to join.
Average Income (000 SEK)	-	Higher income municipalities are more likely to join.
Population (000)	±	The direction of the association is unclear.
Average Age	-	Municipalities with older populations are less likely to become members.
Neighboring municipalities	+	Eco-municipalities might influence program adoption in their neighbors (knowledge spillover).
Urban	-	Urban municipalities are less likely to join relative to rural ones.
Coastline	+	Municipalities with a coastline face a wider range of environmental threats. They are more likely to join SEKOM.

1.4. Data and Methods

1.4.1. Data Description

This study draws on data from multiple sources. The first and most important source is the SEKOM website which provided information on which municipalities were members as well as when they joined the organization. The Statistics Sweden database was another useful data source which provided data on the demographic characteristics of the municipalities.

We combine data from these sources to create a balanced panel with a sample period from 2001 to 2020. Starting with 290 municipalities, we remove six municipalities for which we have no data on their SEKOM join date. We also remove 15 municipalities which joined and subsequently left SEKOM within our sample period, and Knivsta municipality which was created in 2003. We also dropped the two island municipalities of Gotland and Mörbylånga as the spatial weights matrix that we used requires the use of a spatially contiguous unit. Hence, we exclude 24 municipalities in total. This leaves us with 266 municipalities across 20 years resulting in a total of 5,320 municipality-year observations.

One weakness of our data is that it does not cover the first six years of SEKOM's existence, from 1995 (when it was formed) to 2000. While we have data going that far back for some of our variables, several important variables only have data available starting from the 2000s. Despite this, we still have substantial variation in the dependent variable within our sample period. 60 out of the 95 current municipalities joined after 2000 and 171 municipalities have never been members of SEKOM. See Table 1-5 in Appendix 1-A for a list of the years when the municipalities joined. Figure 1-2 shows the municipalities in our analysis sample as well as the years in which they became members.

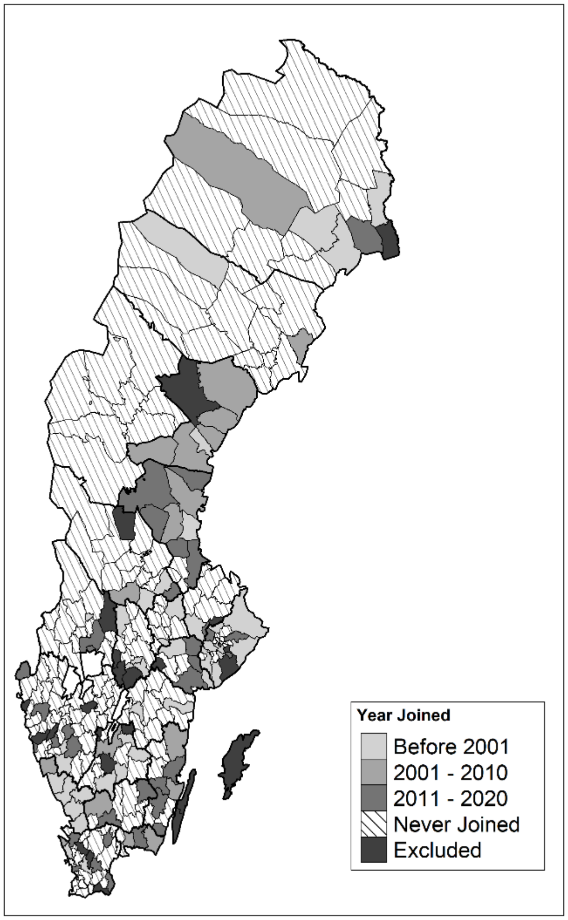

Figure 1-2: Municipalities in our sample

While we do not observe any significant clustering among the excluded municipalities, there appears to be some spatial clustering in who joined and did not join with some clusters of eco-municipalities in coastal areas and non-members towards the inland.

The dependent variable is a binary variable for whether a municipality is a member of SEKOM in the current year. It takes on a value of 1 in the year the municipality joined SEKOM as well as subsequent years and 0 otherwise.

We have already provided arguments for how environmental consciousness, as proxied by the share of Green Party votes, can plausibly affect the probability that it becomes an eco-municipality. Demographic factors such as income, population, average age, industry structure, and educational attainment of the population are likely significant determinants of the decision to participate (see Section 1.3.3).

We include a variable for municipality type based on a municipality classification by SKL (2017) that takes into account proximity to major cities and commuting patterns and divides municipalities into three categories: urban, suburban, and rural municipalities.

Table 1-2 below shows the summary statistics split by SEKOM membership.

Table 1-2: Municipality Summary Statistics

	Eco-Municipalities		**Non-Members**	
	mean	**std.dev**	**mean**	**std.dev**
% Votes for Green Party	*4.61***	*2.58*	*3.82*	*2.67*
% Post-Secondary Education	*26.57***	*7.45*	*24.22*	*8.98*
% Foreign Born	*13.06***	*6.53*	*11.07*	*5.68*
% Employed in Heavy Industry	*17.61***	*10.32*	*21.21*	*12.07*
Average Income (000 SEK)	*248.66****	*45.35*	*230.71*	*48.10*
Population (000)	*45.25*	*97.79*	*29.95*	*54.83*
Average Age	*42.50*	*2.42*	*42.87*	*2.54*
% Coastline	*45.30****	*49.80*	*24.00*	*42.70*
% Rural	*41.90*	*49.40*	*48.20*	*50.00*
% Suburban	*40.70*	*49.10*	*36.60*	*48.20*
% Urban	*17.40*	*37.90*	*15.30*	*36.00*
No of Municipalities (2020)	*95*	-	*171*	-

Note:

1. ***, ** and * denote statistically significant differences between the two groups at the 1%, 5% and 10% levels respectively.
2. Where the variances of the two samples were equal, we used the standard t-test. Otherwise, we used Welch's t-test test which is more appropriate when the samples have unequal variance.

Qualitatively, eco-municipalities do not appear to be very different from the rest of the municipalities. However, a difference in means tests reveals that for most of the variables there are statistically significant differences between the two groups. Eco-municipalities are wealthier, slightly more likely to vote for the Green Party, are more educated, have a higher percentage of foreign-born residents, and have less residents employed in mining and manufacturing. The most substantial differences are income, and coastline both of which are significant at the 1% level. Over 45% of eco-municipalities are on the coast while only 24% of non-members are on the coast and the average personal income in eco-municipalities is about 7% higher than in non-members There are no significant differences for population, average age, and municipality classification. It remains to be seen if any of these differences persist in the regression models.

1.4.2 Econometric Methods

We will model the decision to join the eco-municipality association, SEKOM, using a dichotomous choice model. The municipality's SEKOM participation decision is observed as discrete variable that equals 1 if the municipality participates and 0 otherwise in year *t*. Following Khanna and Damon (1999), we can view the participation decision as depending on the discounted net benefits with and without participation.

The *i*th municipality's net benefit from participating can be given by the unobserved latent variable D^*. The municipality will only join when the net benefits of participation are greater than those of non-participation (i.e., $D_P^* > D_R^*$). All of this is unobserved, what we observe is the decision variable $D_{it} = 1$ if $D_P^* > D_R^*$ or $D_{it} = 0$ when $D_P^* < D_R^*$. We can model this relationship with a probit model as follows:

$$D_{it} = X_{it}\beta' + \varepsilon_{it}, i = 1,2, \ldots, N \qquad 1.1$$

Where D_{it} is the decision variable (to join or not), and X_{it} is a vector of the characteristics of municipality i in year t hypothesized to influence the decision to join the VEP.

Since our dataset is a panel from 2001 to 2020, another matter worth considering is whether to make use of a municipality or county level fixed effects. Here we follow the advice of Allison (2009) and forgo the use of municipality-level fixed effects. The reason for this is that fixed effects at that level only consider within-municipality variation, and for Sweden's municipalities there is very limited within-municipality variation on the response variable. Once a municipality joins SEKOM they are very unlikely to leave, this is made worse by the fact that a step of a data cleaning procedure was to drop those few municipalities that joined and later left the program[5]. For both the baseline (non-spatial) and the spatial models we will make use of county-year fixed effects as there is much more between-county variation in the response variable.

An advantage of using a county-level fixed effects is that it allows us to observe the effect of time invariant municipality characteristics such as municipality type and having a coastline, on eco-municipality membership. We have already discussed in Section 1.2 (the literature review) how it is plausible that adoption decisions of municipalities may be influenced by their neighbors. There may exist structural spatial dependence in the decision on whether to participate in SEKOM and this can be tested by looking at the residuals of the estimated non-spatial models. We do this using the Baltagi, Song and Koh Lagrange Multiplier test which checks for spatial autocorrelation

[5] One alternative that Allison (2009) suggests is to exclude those observations whose values of the response variable do not change over the sample period. This would allow us to still make use of a municipality-level fixed effects model. It is easy to see how doing this would negate the entire point of our analysis as all the municipalities that never joined SEKOM have a time invariant response/dependent variable.

in the residuals. The null hypothesis of the test is that there is no spatial autocorrelation. Rejection of the null would imply that the baseline non-spatial panel is insufficient and a spatial panel model would be preferable (Baltagi, Song, & Koh, 2003).

This spatial dependence is modelled using a Spatial Lag Model (also known as SLM or SAR). We used some model specification tests to decide on the model, this is discussed in Section 1.5.1. The equation for the SLM is given below:

$$Y_i = \mu + \sum_{k=1}^{K} X_k\beta_k + \rho\sum_{j=1}^{n} w_{ij}Y_j + \epsilon_i, \qquad i = 1, \dots, n \qquad 1.2$$

where *X* and *Y* represent the independent and response variables respectively and w_{ij} is the element of the *i*th row and the *j*th column of the spatial weight *w*; Y_i is the dependent variable for the *i*th spatial unit; $\sum_{j=1}^{n} w_{ij}y_j$ is the weighted average of the dependent variable for the neighbors of i (or spatial lag); $\epsilon_i$is the error term; and ρ is the spatial autoregressive parameter which measures the intensity of the spatial dependence. A $\rho = 0$ represents a standard non-spatial regression model, while a $\rho > 0$ indicates positive spatial dependence.

We used a queen contiguity weight matrix computed in GeoDa. Our estimation model is incompatible with neighborless municipalities, so we dropped the two island municipalities of Gotland and Mörbylånga from the sample[6].

[6] An alternative is to use a distance spatial weight matrix instead. Two municipalities would be considered neighbors if they fell within a certain distance of each other. This method avoids missing neighbors by picking the smallest distance such that every municipality has at least one neighbor. In our case that distance is about 128 miles which results in the median municipality having 38 neighbors as opposed to the 5 neighbors we obtain using queen contiguity-based weights.

1.5. Regression Analysis and Results

We will consider two models. The first is a baseline (non-spatial) panel probit model which models the municipality participation decision without attempting to account for spatial dependence. The second is a spatial lag model (SAR) which will account for spatial dependence. Our model specification tests suggest that the data generating process includes a spatial component, for this reason this section will only include the spatial lag model. The results for this baseline (non-spatial) model are reported in Table 1-6 in Appendix 1-B.

1.5.1 Regression Model

For reasons that we have already discussed, our main baseline model is a probit model with county-year fixed effects that models the SEKOM participation decision without attempting to account for spatial effects. The results for this baseline (non-spatial) model are reported in Table 1-6 in Appendix 1-B. Once complete, we use the Baltagi, Song and Koh LM test to test for spatial dependence. We reject the null hypothesis of no spatial dependence which suggests that the non-spatial model alone is inadequate and that we need to use a spatial panel model to account for the dependence. There are several such models to choose from, we will discuss how we make this choice below.

There are two main classes of models that account for spatial dependence, these are the spatial error model (SEM), and the spatial lag model (SAR). In the absence of a theoretical justification for selecting one model over the other, we can make use of Lagrange Multiplier specification tests to select the appropriate model. Table 1-3 shows the results of this model specification test.

Table 1-3: Model Specification Tests

Test	Test Statistic	p-value
LM test for spatial error dependence	*14.78*	*0.00027*
LM test for spatial lag dependence	*32.74*	*1.86e-08*
Robust LM test for spatial error dependence	*31.43*	*1.916e-10*
Robust LM test for spatial lag dependence	*49.38*	*1.667e-14*

Typically, we select the model whose test is significant. In this case however both the LM-Error and LM-Lag models have power against the other alternative, so we must use the robust versions of the tests to select the most appropriate model to use. The robust forms of the test make an asymptotic adjustment to correct for this (see, Anselin, Bera, Florax, & Yoon, 1996). The robust LM-lag model test is the most significant, hence we select that one.

Since our dependent variable is dichotomous, the most appropriate model is a spatial panel logit/probit model. However, while there has been some theory development in this area, there is no readily available software implementation that has the three features we require (i.e., spatial, panel, and logit/probit). The available implementations of spatial probit models make use of Bayesian estimation as opposed to the traditionally used maximum likelihood and generalized method of moments (GMM) approaches and are only implemented for cross-sectional data (Baltagi, Egger, & Kesina, 2016; LeSage & Pace, 2009).

We make use of the spatial probit package by Wilhelm and de Matos (2022) to run our model. Because the base package does not support panel data we modify our spatial weights matrix to allow us to create a pooled model to which we then added county and year dummy variables for the county-year fixed effects (see, Anselin, Gallo, & Jayet, 2008, pg 629)[7]. A more detailed description of this procedure is described in Appendix 1-C.

To allow for interpretability, for both the non-spatial and spatial probit models, we also present the average marginal effects (AME). In both models the average marginal effect represents the how much the predicted probability of joining the eco-municipality association changes for a one-unit change in the explanatory variable. The spatial lag model allows us to decompose the total effect into direct and indirect effects. The direct effect is the effect on the dependent variable of a change in the independent variable for the same spatial unit. Indirect effects are spillover effects. The marginal effects reported for the spatial model in Table 1-4 are direct effects. These are comparable to the marginal effects for the non-spatial model which assumes zero spillover effects (see Table 1-6).

Table 1-4 shows the results of the results of the spatial model. The model coefficients in column 1 are in log odds and the average marginal effects are next to them in column 2.

[7] In addition to the previously mentioned argument by Allison (2009), another reason for opting for county-year rather than municipality-year is that Markov Chain Monte Carlo (MCMC) algorithm employed by the spatial probit model did not converge when municipality-year fixed effects were used.

Table 1-4: Factors influencing SEKOM membership (Spatial Model)

	Dep Variable: SEKOM Membership	
	Log Odds	*Marginal Effect*
% Post-Secondary Education	*0.033***	*0.007***
	(0.015)	
% Voted for Green Party	*0.024****	*0.005****
	(0.009)	
% Foreign Born Residents	*0.007*	*0.001*
	(0.005)	
% Employed in Heavy Industry	*-0.008****	*-0.002****
	(0.002)	
Average Income (0000 SEK)	*0.001*	*0.001*
	(0.001)	
Population (ten thousands)	*0.0003*	*0.001*
	(0.0003)	
Average Age	*-0.010*	*-0.002*
	(0.014)	
Coastline municipality (Yes=1)	*0.165****	*0.033****
	(0.053)	
Municipality Class (Base: Rural)		
Suburban	*0.122***	*0.024***
	(0.047)	
Urban	*-0.082*	*-0.016*
	(0.087)	
Spatial Lag Parameter (ρ)	*0.782****	
	(0.012)	
County Fixed Effects	*Yes*	
Time Fixed Effects	*Yes*	
N	*5,320*	

Notes:

1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively
2. County and year dummies were omitted from the table

The results of the spatial model are very similar to those from the baseline (non-spatial) model (see Table 1-6 in Appendix B). The coefficients of the final model tend to be smaller and less significant. The most significant difference between the two models is the effect of education which switches from negative and significant in the baseline model to positive and significant in the final spatial model.

The spatial lag parameter (ρ) is positive and significant. This suggests that the spatial lag in the dependent variable was not fully accounted for through the socio-economic and demographic variables we included in the baseline model. In addition, this suggests a positive spatial spillover effect where having a neighbor who is already an eco-municipality increases one's likelihood of joining. About half of the coefficients in our spatial model are statistically significant, the exceptions are votes for the foreign born, average income, population, average age, and urban. All of these, except average age, were also insignificant in the baseline model.

1.5.2 Results Discussion

After accounting for spatial dependence, the most significant change is that, in the baseline model post-secondary education was counterintuitively inversely related to the likelihood of SEKOM participation. However, once we account for spatial dependence the sign of the coefficient changes. A 1 percent point increase in the number of residents with a post-secondary education is now associated with a 0.7 percentage point increase in the predicted probability of membership. This is a large effect that is in line with our expectations as the literature on environmental attitudes suggests that years of education are positively related to environmental consciousness.

The percentage of votes for the Green Party variable is positive and significant in both models. A 1 percent point increase in the votes for the Green Party is associated with a 0.5 percentage point increase in the predicted probability of membership. The percentage of foreign-born residents was insignificant in both models. Although not rising to the level of significance, the sign of the coefficient, which is positive, runs counter to our expectation based on the U.S. studies (Hunter, 2000; Johnson et al., 2004) that suggested that foreign-born residents likely have lower levels of environmental concern. A potential explanation is that there may be some omitted variable that is driving both eco-municipality association membership and the decision by foreign-born residents to settle in each area. For example, if environmental quality is a factor in the location choices of migrants and the places with the higher environmental quality tend to be SEKOM members then that could explain a positive relationship. These two, possibly competing forces, could explain the null result.

The employment share of heavy industry is negative and significant in both models. A percentage point increase in the residents employed in heavy industry is associated with a 0.2 percentage point decrease in the likelihood of joining the association. This is in line with the prediction we made in Section 1.3.3. Municipalities that have a large share of their population employed in heavy industry (that results in pollution and other environmental impacts) may be reluctant to join an organization such as SEKOM which has mandatory reporting requirements of various measures of environmental performance. Similar to other studies on the diffusion environmental innovations (Xu et al., 2021), we find a positive spatial spillover where being in close proximity on an eco-municipality appears to increase the odds of becoming one. This is also in line with our prediction in Table 1-1 in Section 1.3.3 and from visually studying the map in Figure 1-2.

Our expectation, based on the environmental Kuznets curve (EKC) hypothesis, was that average income would be positively related with membership. However, although the sign of the coefficient is in the expected direction, we find that average income is not statistically significant. It is worth noting that the bulk of the literature on the EKC hypothesis focuses on making cross country comparisons and their findings may not be directly transferable to a within country comparison such as we are making. Population turns out to be positive and insignificant in our final model.

Having a coastline turned out to have a large effect on the likelihood of joining SEKOM. Being on the coast resulted in a 3.3 percentage point increase in the predicted probability of program participation. This is a relatively large effect, which remained significant (albeit smaller) even after controlling for spatial dependence. The municipality classification also turned out to be significant. Relative to the baseline (rural municipalities), suburban municipalities have an increased predicted probability of participation of about 2.4 points. Urban municipalities on the other hand had a reduced predicted probability of participation of about 1.6 points relative to rural municipalities although this was not significant. Earlier we argued that rural municipalities which tend to have lower levels of environmental spending and quality may obtain greater signaling value from organizations such as SEKOM making them more likely to join than urban municipalities.

We found average age to be negatively related to program participation although not rising to the level of significance in the final model. Again, the sign of the coefficient was expected. Findings from individual level studies suggest that younger people have greater levels of environmental concern and municipalities whose demographics are skewed towards the youth may feel a greater pressure to join organizations such as SEKOM. Interestingly average age was one of the few variables were there was no significant difference between members and non-members in the summary statistics (see Table 1-2).

Figure 1-3 summarizes the key results from the spatial model. It shows the point estimates along with the confidence intervals (90 & 95%) for the statistically significant variables. For readability the coefficients for the continuous variables are rescaled so that they can be interpreted as the effect of 10 percentage point increase in the independent variable on the predicted probability of program adoption. The expected signs of the coefficients are shown on the right section of the plot.

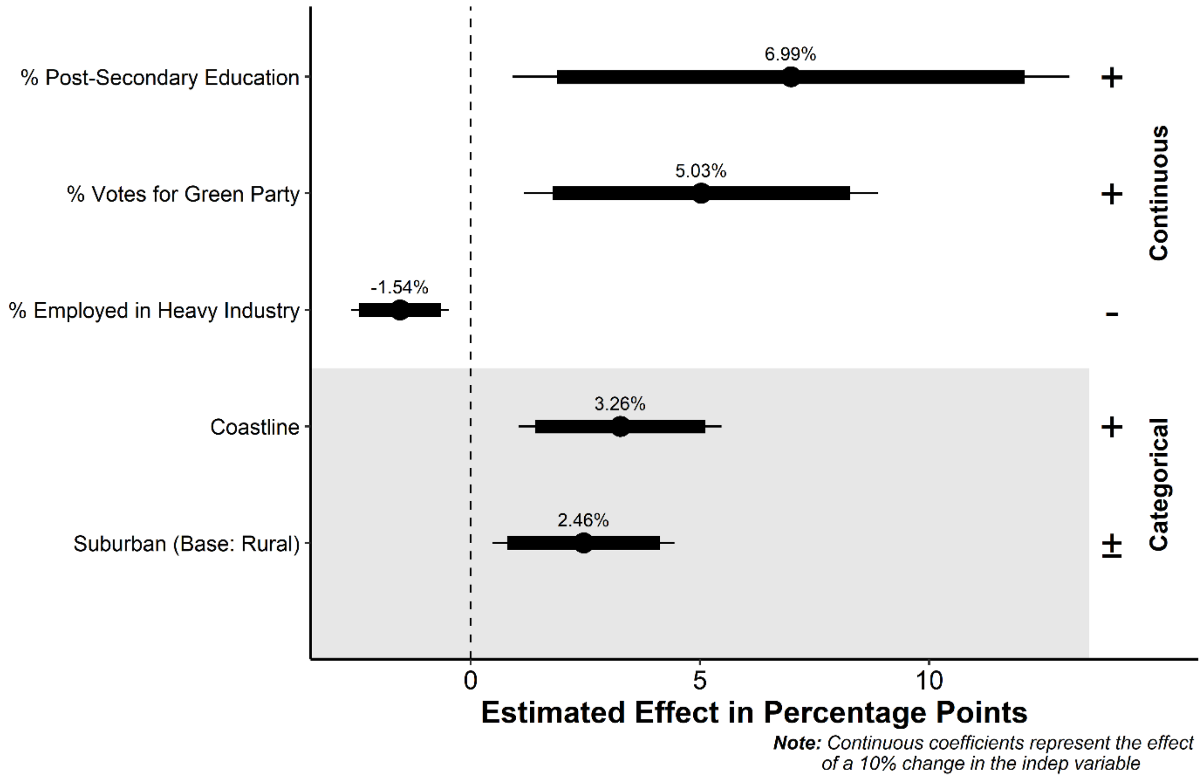

Figure 1-3: Spatial Model Coefficient Plot

As seen in the Figure 1-3, all the significant variables have the expected sign except for the suburban category for which there was no a priori theoretical expectation. Although substantively large, the effect sizes for the spatial model are consistently smaller than those for the baseline model.

1.6. Conclusions

We set out to examine Eco-municipalities as an instance of a public sector VEP and argued that municipalities, which have different stakeholders from private firms, may have different reasons for participating in VEPs. Public sector VEPs may be an attractive policy tool for helping local governments achieve environmental performance over and above the targets set by the federal government.

Our results suggest that environmental consciousness as proxied by share of votes for the Green Party, level of education, and a municipality being suburban and located on the coast are positively associated with program membership. The employment share in heavy industry was negatively associated with program membership. Other municipal attributes such as average age, population, average household income, and foreign-born residents turned out to not be significant. The effect sizes after controlling for spatial dependence tended to be smaller in magnitude and less significant.

Municipal attributes alter the balance of the costs versus benefits of joining SEKOM. For example, a municipality with a large share of employment in heavy industry would be reluctant to join an organization such as SEKOM which has mandatory reporting requirements of various measures of environmental performance. Such a municipality faces a tradeoff of environmental versus economic values such that implementing the environmental measures associated with SEKOM members may present an unacceptably high economic cost. As a result, the cost of joining is higher for regions which are economically reliant on heavy industry which could reduce their likelihood of participation. This example shows how a municipal attribute can influence the cost of program participation.

Municipal attributes can also influence the benefits of joining. Coastal areas present additional challenges in terms of environmental protection that are not faced by non-coastal municipalities. Because of this, municipalities with a coastline may have more to gain from joining an association such as SEKOM. Municipalities compete to attract constituents. Hence, rural municipalities may obtain greater signaling value from the voluntary environmental programs such as SEKOM thus making them more likely to join. However, we do not find such an effect. Municipalities with more educated environmentally conscious residents may also obtain greater signaling value to their residents by joining SEKOM which would increase the benefits of joining.

An alternative way to frame these results is through the lens of institutional capacity. Sharp, Daley, and Lynch (2011), proposed three classes of institutional factors that influence VEP program membership by local governments. These were organized interest and civic capacity, oppositional organized interest, and need or problem severity. Municipalities with a highly educated population, and a high level of environmental consciousness have a higher institutional capacity to mobilize and advocate for environmental improvement. As a result, it is unsurprising that they are more likely to become members. Municipalities for which manufacturing constitutes a large proportion of total employment have an organized and powerful interest group that may have a vested interest in preventing the environmental changes associated with VEP membership. This makes it unsurprising that they are less likely to become members. Finally, municipalities with greater environmental vulnerability (close to the coast) have a greater need for the knowledge sharing and technical assistance available from VEPs. This makes them more likely to become members.

Based on its unique characteristics, each municipality faces a decision on whether to participate. They only participate when the benefits of joining outweigh the costs so that the discounted net benefit is positive. Municipal characteristics can increase the cost of joining but they can also increase the benefits from joining. Just as in the private sector, voluntary environmental programs appear to be worth more to some participants than others and perhaps one way to increase the appeal of such programs is to reduce entry costs while simultaneously increasing program benefits. Whether such public sector VEPs successfully achieve their goal of improving environmental outcomes is another question altogether which requires separate study.

Our results are important for explaining participation in voluntary initiatives not just in Sweden but in other countries and for other kinds of voluntary initiatives for local governments. The reasons for this are twofold. First, although Sweden has the largest number of eco-municipalities the concept and the principles associated with it have been adopted in many other contexts. The idea of bottom-up participatory decision making that follows SEKOM's general principles has spread to municipalities in places like Norway, the Eastern United States, and has served as a model for the Rio Declaration on Environment and Development (Agenda 21). Our results here will likely generalize to similar voluntary initiatives. Second, we expect our results to generalize to local governments with political structure and institutional capacity similar to Swedish municipalities.

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Appendix 1-A: Eco-municipality Membership

This table shows the years when municipalities joined the National Association of Swedish Eco-municipalities (SEKOM). It serves to demonstrate that the municipalities exhibit substantial variation with respect to the dependent variable (SEKOM membership). Even though our sample period (2001 – 2020) does not extend back to the founding of the program in 1995, 60 members (over two thirds of the total membership) joined after 1998. 175 municipalities have never been members of SEKOM and 13 joined and subsequently left the program.

Table 1-5: Eco-municipality Membership

Year Joined	Municipalities
1995	Bollebygd, Ekerö, Eksjö, Eslöv, Falkenberg, Gotland, Hällefors, Hallsberg, Helsingborg, Kumla, Kungsör, Laholm, Luleå, Mark, Munkfors, Nynäshamn, Övertorneå, Sala, Sigtuna, Smedjebacken, Södertälje, Sorsele, Timrå, Trosa, Varberg, Värnamo
1996	Huddinge, Norrtälje
1997	Söderköping, Stockholm, Värmdö
1998	Hylte, Mjölby, Sävsjö, Söderhamn
1999	Sundbyberg
2001	Mönsterås
2002	Hudiksvall, Karlskrona
2004	Kramfors, Robertsfors
2005	Kungsbacka, Örnsköldsvik, Sundsvall
2006	Karlshamn
2008	Jokkmokk, Jönköping, Ludvika
2009	Höganäs, Ljungby, Västervik
2011	Nyköping, Uddevalla, Upplands-Bro
2012	Östra Göinge

2013	Karlstad, Kävlinge, Ronneby
2014	Hörby, Lerum, Nybro, Ockelbo, Öckerö, Uppvidinge
2015	Kalix, Oskarshamn, Strömstad
2016	Nordanstig, Simrishamn, Solna, Tyresö, Vårgårda
2017	Högsby, Österåker, Strängnäs
2018	Ovanåker, Torsås
2019	Ljusdal
Joined and subsequently left	Ale, Askersund, Borgholm, Filipstad, Haninge, Haparanda, Klippan, Mullsjö, Nacka, Orsa, Sotenäs, Vaggeryd, Vingåker
Join dates not available	Degerfors, Höör, Kungälv, Laxå, Sollefteå, Ystad
Never joined	Alingsås, Älvdalen, Alvesta, Älvkarleby, Älvsbyn, Åmål, Arboga, Åre, Årjäng, Arjeplog, Arvidsjaur, Arvika, Åsele, Åstorp, Åtvidaberg, Båstad, Bengtsfors, Berg, Bjurholm, Bjuv, Borlänge, Botkyrka, Boxholm, Bräcke, Bromölla, Dals-Ed, Danderyd, Dorotea, Eda, Emmaboda, Essunga, Fagersta, Falköping, Falun, Färgelanda, Finspång, Flen, Forshaga, Gagnef, Gällivare, Gislaved, Gnosjö, Göteborg, Götene, Grästorp, Grums, Gullspång, Habo, Hagfors, Hallstahammar, Härjedalen, Härryda, Hässleholm, Heby, Herrljunga, Hjo, Hofors, Hultsfred, Järfälla, Kalmar, Karlsborg, Karlskoga, Katrineholm, Kil, Kinda, Kiruna, Knivsta, Köping, Kristianstad, Kristinehamn, Krokom, Landskrona, Lekeberg, Leksand, Lessebo, Lidingö, Lidköping, Lilla Edet, Lindesberg, Linköping, Ljusnarsberg, Lomma, Lund, Lycksele, Lysekil, Malå, Malmö, Malung-Sälen, Mariestad, Markaryd, Mellerud, Mölndal, Mora, Mörbylånga, Motala, Munkedal, Nässjö, Nora, Norberg, Nordmaling, Norrköping, Norsjö, Nykvarn, Ödeshög, Olofström, Örebro, Örkelljunga, Orust, Osby, Östersund, Östhammar, Överkalix, Oxelösund, Pajala, Partille, Perstorp, Piteå, Ragunda, Rättvik, Säffle, Salem, Sandviken, Säter, Sjöbo, Skara, Skellefteå, Skinnskatteberg, Skövde, Skurup, Sollentuna, Sölvesborg, Staffanstorp, Stenungsund, Storfors, Storuman, Strömsund, Sunne, Surahammar, Svalöv, Svedala, Svenljunga, Täby, Tanum, Tibro, Tidaholm, Tierp, Tingsryd, Tjörn, Tomelilla, Töreboda, Torsby, Tranås, Tranemo, Trelleborg, Trollhättan, Ulricehamn, Umeå, Upplands Väsby, Uppsala, Vadstena, Valdemarsvik, Vallentuna, Vänersborg, Vännäs, Vansbro, Vara, Västerås, Vaxholm, Växjö, Vellinge, Vetlanda, Vilhelmina, Vimmerby, Vindeln, Ydre

Note: *Knivsta municipality was only created in January 2003 using parts of Uppsala municipality*.

Appendix 1-B: Non-Spatial Probit Model

Table 1-6 below shows the baseline non-spatial probit model it includes county-year fixed effects. The Baltagi, Song and Koh LM test run on the residuals of the model suggests that there is spatial dependence and that the non-spatial model alone is inadequate meaning that we need to use a spatial panel model.

The results of the baseline model are very similar to those from the final spatial model (see Table 1-4). The coefficients of the final model tend to be smaller and less significant. The most significant difference between the two models is the effect of education which switches from negative and significant in the baseline model to positive and significant in the final spatial model.

Table 1-6: Factors influencing SEKOM membership (Baseline – Non-Spatial Model)

	Dep Variable: SEKOM Membership	
	Log Odds	*Marginal Effect*
% Post-Secondary Education	*-0.0279*******	*-0.007****
	(0.0056)	
% Voted for Green Party	*0.0532****	*0.013****
	(0.0144)	
% Foreign Born Residents	*0.0066*	*0.002*
	(0.0057)	
% Employed in Heavy Industry	*-0.0177****	*-0.004****
	(0.0026)	
Average Income (0000 SEK)	*-0.0160*	*-0.004*
	(0.0143)	
Population (ten thousands)	*0.0047*	*0.001*
	(0.0030)	
Average Age	*-0.0405****	*-0.010****
	(0.0146)	
Coastline municipality (Yes=1)	*0.3960****	*0.105****
	(0.0537)	
Municipality Class (Base: Rural)		
Suburban	*0.2963****	*0.076****
	(0.0547)	
Urban	*-0.0433*	*-0.010*
	(0.1138)	

McKelvey and Zavoina's R^2	*0.375*
Baltagi, Song and Koh LM Test	*56.20*
	(0.0000)
County Fixed Effects	*Yes*
Time Fixed Effects	*Yes*
N	*5,320*

Notes:

1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.
2. County and year dummies were omitted from the table.
3. Heteroskedasticity robust (Huber-White) standard errors are in parentheses.

Appendix 1-C: Spatial Weights Modification Procedure

As mentioned in Section 1.5.1, there is no readily available software implementation of a model that has the three features we require (i.e., spatial, panel, and probit). The spatial probit package we used only supports cross-sectional models (Wilhelm & de Matos, 2022). Fortunately, there exists a simple procedure to modify the original weight matrix so that a pooled spatial panel model can be run using the same package. To add region-time fixed effects, region and time dummy variables can be included.

A summary of this procedure which is also described in Anselin et al. (2008 pg 629). We will detail the steps below:

1. We begin with our standard cross-sectional $W_N = N \times N$ spatial weights matrix where N is the number of spatial units (i.e., 266 in our case).
2. Next, we create an identity matrix I_T where T is the number of periods in our sample (i.e., 20 years from 2001 to 2020).
3. Finally, we perform a Kronecker product $I_T \otimes W_N$
4. The resulting weights matrix W_{NT} has dimensions $NT \times NT$ where NT is the total number of observations in our pooled dataset (i.e., 5320).

ARTICLE 2: ON THE EFFECT OF PUBLIC SECTOR VOLUNTARY ENVIRONMENTAL PROGRAMS ON ENVIRONMENTAL PERFORMANCE: THE CASE OF SWEDISH ECO-MUNICIPALITIES

2.1 Introduction

Voluntary Environmental Programs (VEPs) are organizations whose aim is to help their participants reduce their environmental impacts beyond regulatory requirements. These can be sponsored by government agencies, industry associations or even independent third parties such as non-profits (Darnall, Potoski, & Prakash, 2010). While most of the academic literature has focused on regulator sponsored VEPs targeting private firms, there is a growing recognition of the role that local governments can play in mitigating the impacts of climate change. More recent studies have recognized that public sector entities can also participate in VEPs with the goal to improve their environmental performance (Dolšak & Prakash, 2017; Heikkinen et al., 2020; Hughes, 2012).

The reduction of greenhouse gas (GHG) emissions is an important policy goal in the fight against climate change. The government of Sweden has set a number of policy goals with the aim of reducing GHG emissions. In 2013, Sweden set a target to achieve a fossil independent vehicle fleet by 2030 (SOU, 2013:84). Even before this the government introduced a 10,000 SEK (around USD 1,100) government rebate for environmentally classified vehicles (ECVs)/green vehicles (Pedersen & Hagman, 2010).

In order to reduce the incineration of food waste, in 2003 the government set out to have at least 35% of food waste undergo biological treatment. By 2016, up to two thirds of the municipalities had implemented some form of a food waste collection policy separate from the recycling of non-food items such as glass, paper, plastic, and metal (Ek & Miliute-Plepiene, 2018).

This chapter will examine the impact of membership in Sweden's Eco-Municipality Association (SEKOM) on municipal environmental performance as measured by the adoption of green vehicles, and food waste collection policy.

This chapter builds on the results obtained in Chapter 1 where we modelled the municipality decision to participate in SEKOM (Duma & Nilsson, 2022). In Chapter 1, we found that environmental consciousness (as proxied by the share of votes for the Green Party), level of education, the municipality being suburban, and environmental vulnerability (as proxied by proximity to the coast) were positively associated with program membership. The employment share in heavy industry was negatively associated with program membership. Other municipal attributes such as average age, population, average household income, and foreign-born residents turned out to insignificant in explaining membership in SEKOM.

This Chapter examines the impact of SEKOM membership on the adoption of environmentally classified vehicles (ECVs) or green vehicles, and food waste collection policy. Our results suggest that SEKOM members have a greater adoption of green vehicles. After controlling for self-selection, a 1 percentage point increase in the predicted probability of participation in SEKOM is associated with between 0.102 and 0.143 percentage point increase in the share of green vehicles owned by a municipality. Additionally, we find that average vehicle distance travelled per year is negatively associated with the adoption of green vehicles. This effect is statistically significant with a 100-mile increase in the average distance travelled associated with between a 1.1 to 1.5 percentage point decrease in the percentage of municipally owned green vehicles. One interpretation is that, because range concerns are a main barrier towards the adoption of electric vehicles (a subset of green vehicles), municipalities where travel distances are routinely large may be reluctant to acquire a large number of green vehicles. As a check for this hypothesis we also test whether the range anxiety effect is stronger in the later years of our sample where electric vehicles are a much larger proportion of the ECV category, we find this to be the case.

We also found that SEKOM membership was positively associated with the adoption of food waste collection policy. After controlling for self-selection bias, a 1 percentage point increase in the predicted probability of SEKOM membership is associated with a 3 percent increase in the likelihood of adopting a food waste collection program. This is a substantively large effect. Per capita non-food recycling volume is associated with a higher likelihood of adopting a food waste collection program and this is true across all models. Each additional kilogram of non-food waste per capita recycled is associated with between a 19 percent to a 36 percent increase in the likelihood of adopting a food waste collection program. This is a large effect given that the average per capita non-food waste recycling is around 10 kilograms.

The remainder of this article is structured as follows: Section 2.2 reviews the literature related to the adoption of green vehicles and food waste collection policy. Section 2.3 describes the data and empirical approach used in this chapter. Results are presented in Section 2.4 and concluding remarks are provided in Section 2.5.

2.2 Related Literature

The question of whether VEPs improve the environmental performance of their participants is a very interesting one. In particular, does joining SEKOM improve a municipality's environmental performance improves? Studies on the effectiveness of VEPs in improving environmental outcomes have returned mixed results (Koehler, 2007). Whether or not a program has an impact depends on many program-specific factors especially those relating to the presence of monitoring and enforcement mechanisms to prevent shirking.

The primary mechanisms through which SEKOM influences environmental performance are knowledge sharing/spillovers from being part of the network, and the sense of accountability and transparency resulting from the mandatory reporting requirements. SEKOM facilitates seminars and conferences which serve to educate the employees and elected officials of the municipalities about the latest environmental innovations/initiatives (James & Lahti, 2004). In addition, through such events municipal officials get to meet officials from other municipalities and share insights concerning their current environmental activities.

SEKOM has mandatory reporting requirements for 12 key environmental outcomes such as heavy metal content in the water, percentage of renewable energy at the municipal premises, household waste, utilization rates for public transport, sustainable forestry/agriculture etc. These disclosure requirements put pressure on municipalities to pay more attention to environmental concerns in order to avoid disclosure to stakeholders (such as voters) that they are behind other municipalities in terms of environmental performance. However, most of these measures are not suitable for our analysis as data is only available for the SEKOM members, hence in most cases there is no comparison group.

We will instead look at food waste collection policy and the adoption of environmentally classified vehicles (ECVs). These variables have three ideal features. First, we have data available for both members and non-members which allows us to have a comparison group. Second, both policy areas align with SEKOM's four sustainability principles[8]. Third, both these variables lie completely within the control of local government and not an external third party.

[8] These are described in detail in Article 1. In short, the principles are to reduce dependence of fossil fuels, reduce dependence on synthetic chemicals, reduce encroachment on nature, and to meet human needs fairly and efficiently.

Starting in 1990s Swedish municipalities began setting up food-waste collection for households, restaurants, and grocery stores. We will focus of the adoption of food waste collection for households. This has been implemented through the use of separate bins for household curbside waste pickup as well as communal collection points for food waste. In 2003, the Swedish government set a goal that by 2010 at least 35 percent of food waste should undergo biological treatment (Ek & Miliute-Plepiene, 2018). One way to make this goal possible is to make households separate food waste from other kinds of waste such as paper, plastic, and metal. As of 2016, around two thirds of Swedish municipalities have adopted systems for the separation of food waste. The precise structure of food waste collection policy varies across municipalities. In some municipalities household participation in the program is mandatory. In the remainder of cases, there are economic incentives provided to induce households to sort their waste.

Ek and Miliute-Plepiene (2018) studied the behavioral spillovers of food waste collection policy. Their goal was to determine the effect of having a food waste collection policy in place on the recycling of non-food waste such as glass, paper, plastic, and metal. Our own goal is to examine whether SEKOM membership influences the decision to create a food waste collection policy of any kind. Therefore, we will not discuss the various kinds of food waste collection policy. Since the purpose of SEKOM is to improve environmental outcomes, and food waste recycling is one such outcome, we hypothesize that SEKOM members are more likely to adopt a food waste collection policy.

While food waste recycling programs only started to be adopted in the 1990s, recycling programs of one form or another for non-food waste already exist in all Swedish municipalities. The argument could be made that municipalities with high levels of non-food waste recycling show higher levels of environmental concern and are thus more likely to also adopt a food waste collection program. The Swedish Waste Management authority has data available on the per capita recycling for glass, paper, plastic, and metal for every municipality. We hypothesize that higher levels of non-food waste recycling are associated with a higher likelihood of adopting a food waste collection program.

Environmentally classified vehicles (ECV) are passenger cars and light trucks that meet the environmental car requirements specified by the regulations. We will include all such vehicles that are owned by the municipality and its majority-owned companies. While the term ECV has been in use since the 1980s, the first government definition came in a set of regulations adopted in 1999. This definition came with the first government incentives for such vehicles which came in the form of lower tax rates. ECVs were defined as vehicles equipped with technology allowing them to run on fuels more environmentally friendly than diesel and gasoline. Such vehicles include battery electric vehicles (BEV), hybrids, gas (natural or biogas), ethanol/petroleum blend, and diesel and gasoline vehicles with emissions below 120 grams of CO_2 per kilometer (Pedersen & Hagman, 2010).

The definition of ECVs has undergone several revisions, first in 2004 and then again in 2006. The largest of these changes was associated with a rebate program of 10,000 SEK which was introduced in 2007 to promote green cars. Some have criticized the ECV category for being too broad. One example of this is the inclusion of ethanol/petroleum blend vehicles (even SUVs) a lot of which are made by Swedish manufacturers (Pedersen & Hagman, 2010). One of the founding principles of SEKOM is to reduce dependence on fossil fuels, given that green vehicles help to achieve this goal, we hypothesize that SEKOM members will have a greater percentage of environmentally classified vehicles (ECVs) than non-members.

A study by Egbue and Long (2012) conducted a consumer survey to determine the main barriers to the adoption of electric vehicle (which are a subset of ECVs). They found that one of the biggest barriers was what they termed range anxiety, which is the concern that because of the limited range of EVs (both perceived and actual) one might get stranded and be unable to reach their destination. Egnér and Trosvik (2018) explored the adoption of electric vehicles by municipal residents in Sweden and found that average vehicle kilometers travelled (AVKT) in a municipality was negatively associated with the adoption of electric vehicles. They attributed this to range anxiety, where residents in municipalities with greater average driving distances were more reluctant to adopt electric vehicles because of concerns about their limited driving range. This same argument could also be applied to the acquisition of ECVs by municipalities. We hypothesize that municipalities with greater average driving distances will have a lower adoption of ECVs (green vehicles).

In our case, one concern with the range anxiety interpretation is that the existing literature on range anxiety relates only to electric vehicles and plug-in-hybrids, while our green vehicle dependent variable is composed of other classes of environmentally classified vehicles such as ethanol hybrids, natural gas/biogas hybrids etc. While there is no breakdown for the various categories for municipally owned ECVs, we have that data available for civilian owned passenger ECVs (Statistics Sweden, 2021). By the 2020, electric vehicles (along with plug-in-hybrids) and ethanol hybrids are the two largest categories of resident owner passenger green vehicles. Figure 2-1 plots these as a percentage of the total number of registered resident passenger green vehicles.

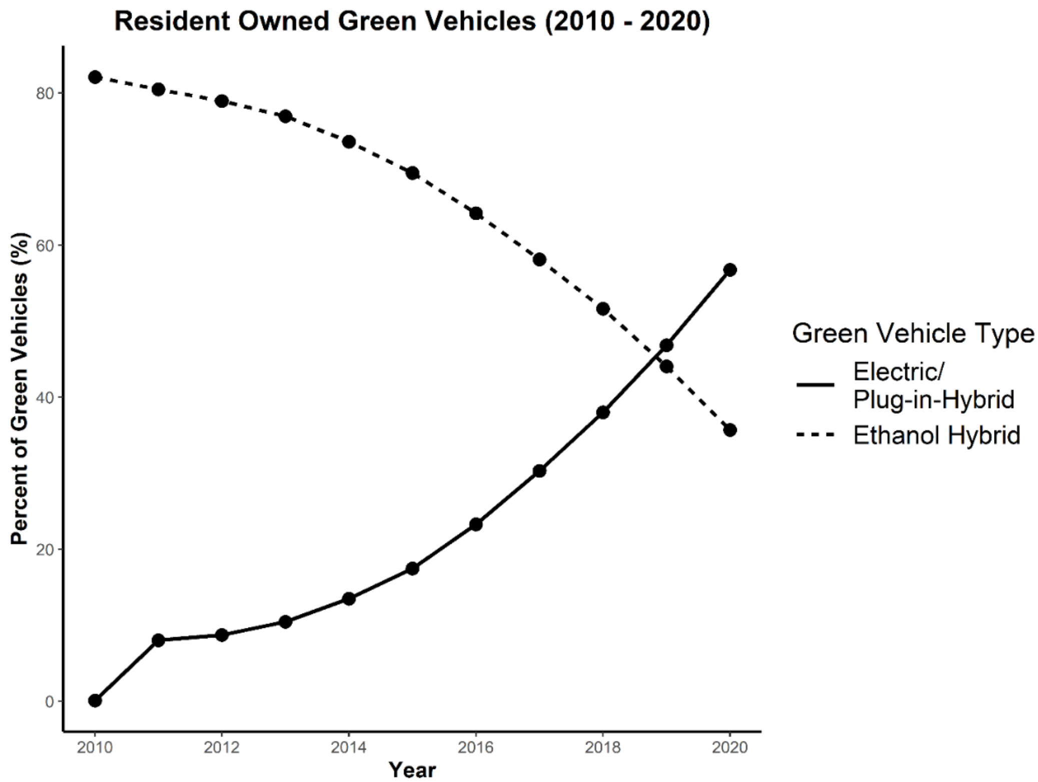

Figure 2-1: Electric Vehicles and Ethanol Hybrids as a percentage of Resident Owned ECVs

At the start of the sample period electric vehicles and plug-in-hybrids are less than 1% of the resident owned green vehicles. This number rises to around 57% by the end of 2020. Ethanol hybrids dominate the sample at the beginning starting from 82% and falling to 36% by the end of 2020. We will make the assumption that a similar pattern holds for municipally owned green vehicles. This allows us to test the range anxiety hypothesis by running regression models that use the early years in the sample period and comparing them with models based on the later part of the sample. The expectation is that the coefficients associated with average mileage will be larger for the models based on the later sample.

The full set of hypotheses we explore in this chapter is summarized below:

$\boldsymbol{H_1}$: The percentage of municipally owned green vehicles will be higher in SEKOM members than in non-members.

$\boldsymbol{H_2}$: Municipalities with a higher per capita driving mileage will have a lower adoption of ECVs (green vehicles).

$\boldsymbol{H_3}$: Eco-municipalities are more likely to implement the household food waste collection policy.

$\boldsymbol{H_4}$**:** Municipalities with a higher per capita non-food waste recycling (i.e., glass, plastic, paper, and metal) are more likely to adopt a food waste collection program

Finally, we will consider some of the methodological difficulties associated with trying to measure the effectiveness of VEPs. According to Morgenstern and Pizer (2007b), the chief difficultly is to distinguish between improvements in performance attributable to the voluntary programs and those that would have taken place anyway. Organizations are not randomly assigned into the SEKOM, but they self-select. The ones that choose to participate are likely systematically different from those who do not. Membership may be endogenous with the same factors that influence the environmental improvement, so we need to control for this self-selection bias. To account for this, we make use of a two-stage estimation procedure that begins by modelling the probability of participating in the program, and then use this to estimate the outcome of program participation (Hartman, 1988; Khanna & Damon, 1999; King & Lenox, 2000; Lubell, Schneider, Scholz, & Mete, 2002). The complete procedure is described in greater detail in Section 2.3.2.

2.3 Data and Methods

2.3.1 Data Description

Our main goal is to examine the impact of SEKOM membership on two variables; municipal green vehicle adoption, and municipal food waste collection policy. We have created a dataset comprised of annual municipal level data between 2006 and 2020. Of this period, data on municipally owned green vehicles is only available from 2009 to 2020, so we will restrict analysis of the first question to this period. Similarly, data for municipal food waste collection policy is only available from 2006 to 2016.

This study builds on the dataset used in Article 1 where we modelled the factors influencing the decision to join the eco-municipality association. The reason for this is that as part of a procedure for accounting for self-selection bias, we make use of a two-stage estimation procedure. The first stage (which is Chapter 1), models the municipality's decision to join SEKOM. The second stage, which is this Chapter takes the predicted probability of joining SEKOM from the first stage and uses it as an explanatory variable in models estimating the effect of membership on environmental performance. The first stage model was run on a sample of 266 out of Sweden's 290 municipalities using variables such as education, environmental consciousness (as proxied by green party votes), foreign born residents, employment in heavy industry, average income, population, average age, environmental vulnerability (as proxied by proximity to the coast), and municipality type (urban/rural).

In addition to those variables we add, the predicted probability of participating in SEKOM, the percentage of municipally owned environmentally classified vehicles (ECVs), the adoption of a food waste collection program, annual miles travelled by municipal residents in passenger cars, and average non-food waste recycling per capita.

There are two dependent variables, each is aligned with the hypotheses defined in the introduction section. The first is the percentage of municipally owned green vehicles. The data for EVCs was obtained from Kolada (2021). For vehicles registered before January 2013, they use the 2004 definition of ECVs (SFS 2004:1364). For all other vehicles they use the 2006 definition of green vehicles (Road Traffic Tax Act SFS 2006:227). This change in definitions should not present any econometric difficulties for use as it applies equally to all the municipalities in our sample.

There is on data available on the subcategories of municipally owned green vehicles. The second is a binary variable for whether a municipality has adopted a food waste collection program. The food waste data was obtained from a study by Ek and Miliute-Plepiene (2018) in which they considered whether food waste collection had spillover effects on household plastic, paper, and metal recycling.

We combine this data to create a dataset for each set of hypotheses. The dataset to test hypotheses related to green vehicles spans 2009 to 2020 with 95 eco-municipalities and 171 non-members creating a balanced panel with 3,192 observations. The dataset to test hypotheses related to food waste collection spans 2006 to 2016 with 74 eco-municipalities and 151 non-members creating a balanced panel of 2,475 observations.

Table 2-1 below describes the main variables and shows their sources.

Table 2-1: Variables and Data Sources

Variable	Definition	Data Source
Dependent Variables		
% Green Vehicles	Percent of municipally owned ECVs	RKA (Kolada)
Food Waste	Binary variable for whether a municipality has implemented a household food waste collection program.	Ek and Miliute-Plepiene (2018)
Key Independent Variables		
SEKOM membership	Binary variable for whether a municipality is a member of SEKOM in the current year.	SEKOM (2022)
Predicted Probability of Participation	Predicted Probability of joining SEKOM.	Regression first stage.
Industry	Employment share of heavy industry.	Statistics Sweden
Green Party votes	Vote share for the Green Party in the last election (%)	Statistics Sweden (2021)
Demographic Variables		
Income	Average annual income (thousands SEK)	Statistics Sweden (2021)
Population	Population	Statistics Sweden
Foreign born	Percentage of foreign-born residents	Statistics Sweden

Education	Percentage of the population with a college education	Statistics Sweden (2021)
Municipality Type	Municipality Designation (Urban/ Suburban/ Rural)	SKL (2017)
Additional Control Variables		
Per Capita Mileage	Per capita miles travelled by the residents of a municipality.	Transport Analysis (2022)
Non-Food Recycling /capita	Per capita non-food waste recycling (kg)	Swedish Waste Management

In Figure 2-2 we plot the adoption of green vehicles and food waste collection by SEKOM membership. The plot on the left shows the percentage of municipalities that have adopted the household food waste collection policy. The plot on the right shows the average percentage of ECVs or green vehicles owned by each group of municipalities. These should allow us to gain a sense of whether eco-municipalities are more likely to adopt these pro-environmental policies.

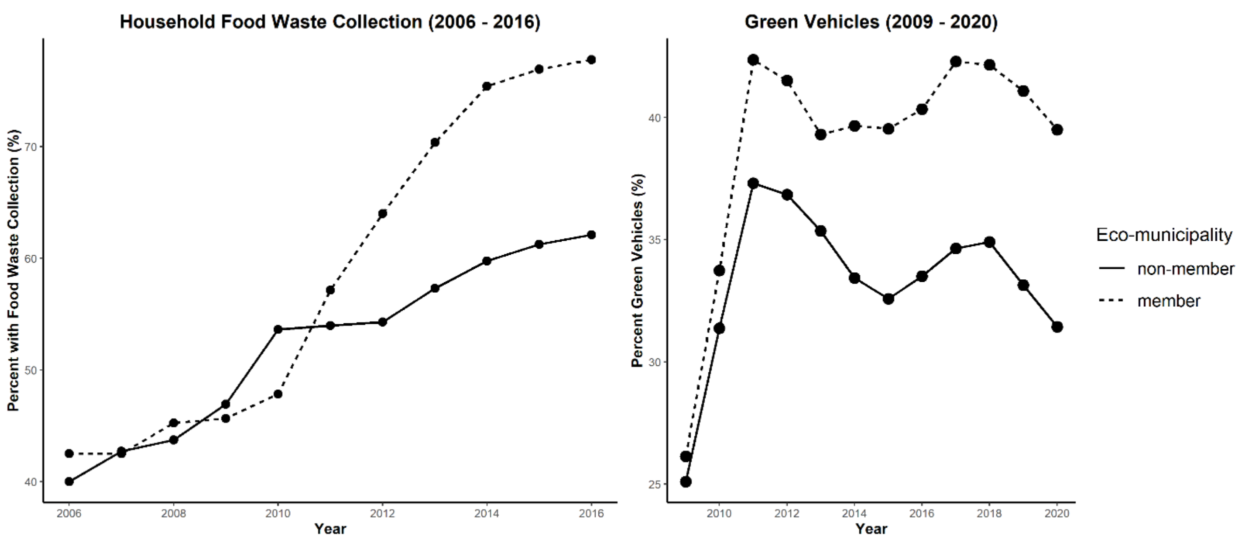

Figure 2-2: Policy adoption by SEKOM membership

A visual inspection of Figure 2-2 suggests that, in general, eco-municipalities are more likely to adopt both green vehicles and household food waste collection. For almost all the years in the respective samples eco-municipalities led the way in the adoption of these policies. We will of course have to wait for the econometric analysis so we can account for the many other factors that could be responsible for this difference. We observe a large increase in the percentage of green vehicles owned by municipalities at the beginning of the series. This increase is almost certainly attributable to the 10,000 SEK (around USD 1,100) government rebate for ECVs which was introduced in 2007 (see, Pedersen & Hagman, 2010). Although municipal data on green vehicle ownership is only available from 2009 onwards, what we observe is likely the continuation of a trend that started in 2007.

Table 2-2 below shows the summary statistics split by SEKOM membership.

Table 2-2: Municipality Summary Statistics

	Eco-Municipalities		**Non-Members**	
	mean	**std.dev**	**mean**	**std.dev**
Predicted Probability of Joining SEKOM	*0.468****	*0.249*	*0.233*	*0.155*
% Green Vehicles	*39.42****	*18.29*	*33.26*	*19.15*
Annual Mileage / capita	*726.59****	*99.78*	*761.24*	*107.31*
Adopted Waste Collection Program	*0.661****	*0.474*	*0.559*	*0.497*
Non-Food Recycling / capita (kg)	*9.90*	*2.67*	*9.91*	*3.20*
% Votes for Green Party	*4.94****	*2.71*	*4.20*	*2.58*
% Post-Secondary Education	*28.32****	*7.22*	*26.18*	*9.09*
% Foreign Born	*14.30****	*6.56*	*12.76*	*5.78*
% Employed in Heavy Industry	*15.61****	*9.40*	*18.77*	*11.11*
Average Income (000 SEK)	*268.02****	*36.85*	*257.17*	*42.90*
Population (000)	*47.06****	*103.35*	*29.76*	*53.33*
Average Age	*42.80*	*2.43*	*43.39*	*2.60*
% Rural	*0.431*	*0.495*	*0.481*	*0.500*
% Suburban	*0.391*	*0.488*	*0.369*	*0.483*
% Urban	*0.178*	*0.383*	*0.149*	*0.357*
No of Municipalities (2020)	*95*	-	*171*	-

Note:

3. ***, ** and * denote statistically significant differences between the two groups at the 1%, 5% and 10% levels respectively.
4. Where the variances of the two samples were equal, we used the standard *t*-test. Otherwise, we used Welch's *t*-test test which is more appropriate when the samples have unequal variance.

Within this sample eco-municipalities appear to be significantly different from non-members along a wide range of variables. As expected, the predicted probability of joining SEKOM that we obtained from Chapter 1 is much higher for members than non-members. Eco-municipalities have a higher adoption of environmentally classified vehicles (ECVs) than non-members. Residents in SEKOM municipalities have a lower average annual mileage, more votes for the green party, higher levels of education, higher income, and larger populations.

Somewhat surprisingly, there is no difference in the rate of non-food recycling between eco-municipalities and non-members. In addition, average age is statistically the same across the groups.

2.3.2 Econometric Methods

The primary methodological issue that arises when attempting to measure the impact of SEKOM membership on environmental outcomes is that of self-selection. Measuring the impact of then program requires a counterfactual i.e., how would the municipality have performed had it not joined the program. The decision to join a green club is not exogenous and may well depend on the same observable and unobservable factors that influence the environmental improvement (Khanna & Damon, 1999). Organizations that join VEPs are likely to differ systematically from those that do not, as a result, organizations that did not join may not be an appropriate comparison group. Ideally, we would randomly assign organizations to join the VEP and then use the remaining ones as a control group (Morgenstern & Pizer, 2007a; Potoski & Prakash, 2005).

We account for this non-random assignment by using a treatment effects model. To do this we model the participation decision of the municipality as an endogenous variable (Hartman, 1988; Lubell et al., 2002). Following Hartman 1988 we use a two-stage estimation method. The first stage consists of modeling the probability of becoming an eco-municipality. This was the subject of Chapter 1 where we modeled the municipality participation decision using a spatial dichotomous choice model (Duma & Nilsson, 2022)[9].

In the second stage (which is the subject of this Chapter) we then use that estimated probability as a covariate in a regression model that models whether program membership has had any impact on municipal environmental performance.

The estimation procedure is detailed below:

1 **Stage 1:** We model the program participation decision by using a probabilistic choice model (logit/probit). This is done in Chapter 1.

$$\widehat{D}_{it} = F\left(X_{2it}.\hat{\beta}_2\right) \quad 2.1$$

2 **Stage 2:** To control for self-selection bias, we use the predicted probability from Stage 1 ($\widehat{D}_{it}$) as an explanatory variable for the second stage model. This used to test hypotheses 1 and 2.

$$Y_{it} = \delta_i + X_{1it}.\beta_1 + \alpha.\widehat{D}_{it} + \epsilon_{it} \quad 2.2$$

Where Y_{it} is the environmental policy outcome, δ_i is the municipality effect, X_{1it} is a vector of control variables, and $\widehat{D}_{it}$ is the predicted probability of program participation.

Similar to Khanna and Damon (1999), our main independent variable for modeling whether VEP membership had any impact on actual environmental performance will be the predicted probability of joining the VEP. The model coefficient α will represent the effect of a change in the predicted probability of program participation on the environmental policy outcome. The

[9] The spatial model from Chapter 1 can accurately predict whether a municipality is a member about 79% of the time.

second stage regression will allow us to find whether SEKOM membership has any impact on the adoption of the food waste collection policy and municipal green vehicle ownership.

The two stage estimation procedure accounts for self-selection bias, and controls for municipality specific characteristics. In addition, the county-year fixed effects control for unobserved county level factors that are time-invariant. This approach does not however account for unobserved municipality and county characteristics that may vary over time. An example of such a factor could be a municipality/county level policy implemented during the sample period that affects environmental performance and is also related the decision to join SEKOM. The result of this is that we do not claim to obtain causal estimates from this analysis and all discussion will be framed in terms of associations.

2.4 Regression Analysis and Results

We will begin in Section 2.4.1 by considering a set of regression models that examine the impact of SEKOM membership on the percentage of municipally owned green vehicles. In Section 2.4.2, we examine the effect of SEKOM membership on the adoption of a food waste collection policy by the municipalities. In both cases we make use of county-year fixed effects for two sets of models, one set that does not account for self-selection bias, and another that does.

2.4.1 Green Vehicle Adoption

We estimate two sets of models for our dependent variable. The first set makes no attempt to control for self-selection bias and serves as a baseline model. This set of models simply regresses the dependent variable (percentage of green vehicles) against a binary variable for whether the municipality is a member of SEKOM in a given year. As we have already discussed in Section

2.3, the decision to join SEKOM is not random and so members may systematically differ from non-members in ways that our models may not adequately account for.

The second set of models accounts for the self-selection bias by making use of the two-stage estimation procedure described in Section 2.3.2. The first stage results were computed in Chapter 1, here we make us of those results to run the second stage of the model. This set of models regresses the dependent variable (percent green vehicles) against the predicted probability of program participation. The resulting coefficient is interpreted as the effect of a change in the predicted probability of participation on the percentage of green vehicles owned by the municipalities.

Each of these sets of models contains two regressions based on different subsets of the data. The first subset is the full dataset containing both members and non-members across the entire sample period from 2009 to 2020. One weakness of using this sample is that 55 out of the 95 eco-municipalities in this sample joined before the beginning of the sample period so there is no variation in the main independent variable for those municipalities.

The second subset gets around this difficulty dropping all the SEKOM members who joined before the start of our sample in 2009. This allows us to have much more variation in the main independent variable as every member remaining in this sample has at least one period during which they are not a member. This allows us to compare not just members to non-members, but members to themselves before they joined.

Table 2-3 shows the results of the models estimating the impact of SEKOM membership on the adoption of green vehicles. The set of columns on the left shows the results for the set of models which do not account for self-selection bias and the columns on the right indicate the models that use the two-stage procedure described in Section 2.3.2 to account for self-selection.

Table 2-3: Effect of SEKOM membership on Green Vehicle Adoption

	No Self-Selection Control		*Self-Selection Control*	
	Full Sample	*Joined (post-2009)*	*Full Sample*	*Joined (post-2009)*
SEKOM Member (Yes/No)	*1.783**** *(0.623)*	*2.106*** *(0.889)*		
Predicted Prob of Participation (× 100)			*0.102**** *(0.028)*	*0.143**** *(0.031)*
% Post-Secondary Education	*0.445**** *(0.100)*	*0.354**** *(0.114)*	*0.511**** *(0.100)*	*0.443**** *(0.114)*
% Voted for Green Party	*0.313*** *(0.154)*	*0.520**** *(0.176)*	*0.193* *(0.160)*	*0.334** *(0.183)*
% Foreign Born Residents	*0.140** *(0.074)*	*-0.060* *(0.096)*	*0.139** *(0.074)*	*-0.058* *(0.095)*
% Employed in Heavy Industry	*-0.151**** *(0.035)*	*-0.152**** *(0.038)*	*-0.116**** *(0.037)*	*-0.101*** *(0.040)*
Population	*0.569**** *(0.045)*	*0.750**** *(0.110)*	*0.537**** *(0.045)*	*0.701**** *(0.104)*
Population Density	*-0.001** *(0.001)*	*0.002* *(0.001)*	*-0.001* *(0.001)*	*0.003*** *(0.001)*
Average Income (000 SEK)	*0.408** *(0.211)*	*0.209* *(0.241)*	*0.419*** *(0.212)*	*0.263* *(0.243)*
Average Age	*-0.251* *(0.169)*	*-0.280* *(0.185)*	*-0.172* *(0.171)*	*-0.201* *(0.184)*
Per Capita Mileage	*-0.015**** *(0.005)*	*-0.013*** *(0.005)*	*-0.013**** *(0.005)*	*-0.011*** *(0.005)*
Municipality Class (Base: Rural)				
Suburban	*2.306**** *(0.644)*	*1.943**** *(0.699)*	*1.847**** *(0.661)*	*1.155* *(0.720)*
Urban	*-7.063**** *(1.426)*	*-5.423**** *(1.576)*	*-6.735**** *(1.441)*	*-5.299**** *(1.601)*
Observations	*3,192*	*2,532*	*3,192*	*2,532*
SEKOM (Yes/No)	*95/171*	*40/171*	*95/171*	*40/171*
Adjusted R^2	*0.468*	*0.474*	*0.468*	*0.477*

Notes:

3. ****, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively*
4. *County and year dummies were omitted from the table.*
5. *Huber-White standard errors clustered at the county level are in parentheses.*

We observe positive and significant effects on our main independent variable for both sets of models. Before accounting for self-selection, we find that SEKOM membership increases the percentage of green vehicles owned by the municipality by between 1.8 and 2.1 percentage points. The interpretation for the second set of models is slightly different. Following Khanna and Damon (1999) we find that, after controlling for self-selection a 1 percentage point increase in the predicted probability of participation in SEKOM is associated with between 0.102 and 0.143 percentage point increase in the percentage of green vehicles owned by a municipality. These results are in line with our hypothesis that SEKOM membership is positively associated with the adoption of green vehicles.

The coefficients of the rest of the control variables, except for municipality classification, are largely consistent with our expectations. Municipalities with higher education levels, and greater environmental consciousness (as proxied by green party votes) are ahead in the adoption of green vehicles. The major surprise is that across all the models, urban areas are less likely to adopt ECVs after controlling for per capita mileage. While we expect the infrastructure for electric vehicles such as public charging stations to be more readily available in urban than in rural areas, this is not as clear for other subcategories of ECVs such as biogas/gas and ethanol hybrids. Suburban municipalities are more likely to adopt ECVs than rural municipalities which is not unexpected.

In line with hypothesis 2, we find that average vehicle distance travelled per year is negatively associated with the adoption of green vehicles. This effect is statistically significant with a 100-mile increase in the average distance travelled associated with between a 1.1 to 1.5 percentage point decrease in the percentage of municipally owned green vehicles. We interpret this to be partially because of the range anxiety that is associated with a subset of green vehicles, municipalities where average travel distances are large would be less likely to procure green vehicles if they had concerns both the range limitations of the vehicles.

One difficulty with this interpretation is that the literature on range anxiety relates only to electric vehicles and plug-in-hybrids, while the green vehicle dependent variable is composed of other classes of environmentally classified vehicles such as ethanol hybrids, natural gas/biogas hybrids etc. In addition, as shown in Figure 2-1, albeit for civilian vehicles, the composition of this category varies over time. In 2009 (when our sample begins), electric vehicles constitute a very small portion of the vehicle stocks in Sweden, however this grows rapidly overtime. As we have noted before, we have no access to data that disaggregates municipally owned green vehicles into the various subcategories.

In order to make a stronger case for the range anxiety interpretation, we rerun the most restrictive of our Green Vehicles models (column 4 in Table 2-3) on three subsamples of the full dataset. We make the assumption that the adoption of green vehicles by municipalities follows a similar pattern to that by residents. Namely, that ethanol hybrids constitute the majority of ECVs in the early years but are rapidly replaced by electric vehicles and plug-in-hybrids (see Figure 2-1). The first sample consists of the early period within our sample where ethanol hybrids are the most common (2009 – 2014). The second is just the full sample run in column 4 of Table 2-3. The third and final sample is the later period where electric vehicles and plug-in-hybrids constitute most of the green vehicles.

The idea is that if the relationship between distance travelled per capita and the percentage of municipally owned green vehicles is attributable to range anxiety, then this effect should be stronger in the period where electric vehicles make up most of the green vehicles. Figure 2-3 shows the coefficients for the Per Capita Mileage variables for the three subsamples along with 90% and 95% confidence intervals.

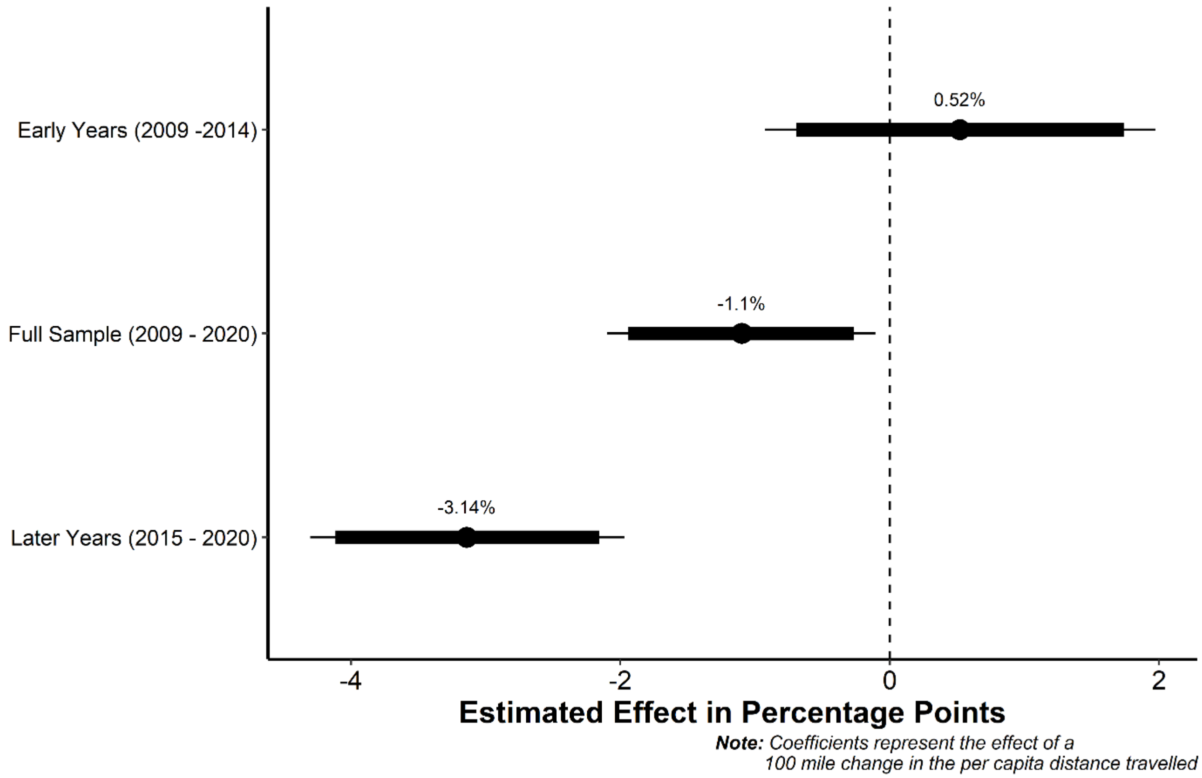

Figure 2-3: Alternative Models - The effect of a 100-mile increase in Per Capita Distance on the percentage of Municipally owned ECVs

The results corroborate the range anxiety interpretation. For the first sample (2009 - 2014), where electric vehicles constitute a small proportion of ECVs, the effect of average distance travelled on the adoption of green vehicles is small and statistically insignificant. The sample including the entire period (2009 – 2020) which is also reported in column 4 of Table 2-3 shows a negative and statistically significant effect. A 100-mile increase in average driving distance is associated with 1.1 percentage point decrease in the adoption of green vehicles. The effect for the later period (2015 - 2020) is even larger with a 100-mile increase in average driving distance associated with 3.14 percentage point decrease in the adoption of green vehicles.

2.4.2 Food Waste Collection Policy

In this section we explore the effect of eco-municipality membership on the adoption of food waste collection policy. This time the dependent variable is a binary value equal to 1 if the municipality has adopted a food waste collection policy, and 0 otherwise. Because of this we will make use of a logistic regression model with county-year fixed effects. Here we follow the advice of Allison (2009) and forgo the use of municipality-level fixed effects in favor of county-year fixed effects. The reason for this is that fixed effects at that level only consider within-municipality variation, and for Sweden's municipalities there is very limited within-municipality variation on the response variable (adoption of a food waste collection program). Of the municipalities that adopted a food waste collection program, none of them none of them end the policy at any point within our sample.

Just as in the previous section, we estimate two sets of models for our dependent variable. The first set makes no attempt to control for self-selection bias and serves as a baseline model. The second accounts for the self-selection bias by making use of the two-stage estimation procedure already described in Section 2.3.2. For each set of models, the data is subset in the same way as in Section 2.4.2. One subset contains the full sample period from 2006 to 2016 and the other drops all SEKOM members who joined before the beginning of the sample period.

Table 2-4 below shows results of the models estimating the impact of SEKOM membership on the adoption food waste collection policy. The set of columns on the left shows the results for the set of models which do not account for self-selection bias and the columns on the right indicate the models do. The coefficients are reported as odds ratios to allow for easier interpretation. An odds ratio (OR) of 1 indicates no association, an odds ratio of less than 1 indicates a negative relationship and a greater than 1 is a positive one.

Table 2-4: Impact of SEKOM membership on Food Waste Collection Policy

	No Self-Selection Control		Self-Selection Control	
	Full Sample	*Joined (post-2006)*	*Full Sample*	*Joined (post-2006)*
SEKOM Member (Yes/No)	*1.06*	*4.06*****		
	(0.12)	(2.03)		
Predicted Prob of Participation (× 100)			*0.98*	*1.03*****
			(-1.01)	*(2.09)*
% Post-Secondary Education	*1.13*	*1.21**	*1.12*	*1.21******
	(1.63)	*(1.93)*	*(1.47)*	*(3.89)*
% Voted for Green Party	*1.09*	*0.97*	*1.12**	*0.98*
	(1.45)	*(-0.17)*	*(1.77)*	*(-0.24)*
% Foreign Born Residents	*1.09**	*1.08*	*1.09**	*1.06**
	(1.74)	*(1.05)*	*(1.90)*	*(1.79)*
% Employed in Heavy Industry	*1.02*	*1.05******	*1.01*	*1.06******
	(1.06)	*(2.75)*	*(0.80)*	*(4.23)*
Population (thousands)	*1.50******	*1.30**	*1.53******	*1.30******
	(2.58)	*(1.90)*	*(2.62)*	*(3.07)*
Population Density	*1.00*	*1.00*	*1.00*	*1.00*
	(-0.45)	*(-0.68)*	*(-0.60)*	*(-0.63)*
Average Income (000 SEK)	*0.84*	*0.76*	*0.85*	*0.78*****
	(-0.73)	*(-0.97)*	*(-0.68)*	*(-2.39)*
Average Age	*1.16*	*1.08*	*1.15*	*1.08*
	(1.42)	*(0.38)*	*(1.31)*	*(0.91)*
Per Capita Non-Food Recycling (kg)	*1.19*****	*1.36*****	*1.20*****	*1.36******
	(2.36)	*(2.12)*	*(2.33)*	*(6.51)*
Municipality Class (Base: Rural)				
Suburban	*4.27******	*2.85*	*4.58******	*2.19******
	(3.01)	*(1.38)*	*(3.38)*	*(2.58)*
Urban	*1.76*	*1.56*	*1.66*	*1.48*
	(0.41)	*(0.52)*	*(0.36)*	*(0.65)*
Observations	*2,475*	*1,287*	*2,475*	*1,287*
SEKOM (Yes/No)	*74/151*	*20/97*	*74/151*	*20/97*
Adjusted R^2	*0.412*	*0.531*	*0.445*	*0.526*

Notes:

1. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively
2. County and year dummies were omitted from the table
3. All coefficients are odds ratios
4. T statistics are reported in parentheses because the standard errors for odds ratios are unintuitive.

Our results here are little more mixed. The effect SEKOM membership is positive across all models but is only statistically significant in our most restrictive models which constrain our sample to only municipalities that either never joined both programs, or that joined at some point in our sample period (2006 - 2016). Before controlling for self-selection bias, compared to non-members, SEKOM membership are 4.06 times more likely to adopt a food waste collection program. In the model that controls for self-selection bias (column 4, Table 2-4) a 1 percentage point increase in the predicted probability of SEKOM membership is associated with a 3 percent increase in the likelihood of adopting a food waste collection program. Both are substantively large effects.

In line with hypothesis 4, the per capita non-food waste recycling has a positive and significant effect on the adoption of a food waste collection program, and this is true across all models. Each additional kilogram of non-food waste per capita recycled is associated with between a 19 percent to a 36 percent increase in the likelihood of adopting a food waste collection program. This is a large effect given that the average per capita non-food waste recycling is around 10 kilograms. This is not unexpected as municipalities with a higher non-food waste recycling likely have both a greater capacity and interest in recycling.

Some of the other control variables are also interesting. More populous municipalities are more likely to adopt food waste collection, and this is consistent across all models. This could be a result of economies of scale. The fixed costs associated with setting up a food waste collection program, and the biological treatment of such waste may only be justifiable for municipalities with large populations. Compared to rural areas, suburban municipalities are more likely to adopt the policy. There is no significant difference between rural and urban municipalities.

2.5 Conclusions

We set out to test two sets of hypotheses. The first set had to do with the adoption of environmentally classified vehicles (ECVs) or green vehicles by municipalities. We hypothesized that SEKOM membership increased the adoption of green vehicles, and that because range anxiety is a barrier to the widespread adoption of electric vehicles, municipalities with high average vehicle distance travelled per year would have a lower adoption of green vehicles.

We found significant evidence for both these hypotheses. Whether we controlled for self-selection or not, eco-municipality membership was associated with a greater adoption of green vehicles. After controlling for self-selection, we find that a 1 percentage point increase in the predicted probability of participation in SEKOM is associated with between 0.102 and 0.143 percentage point increase in the percentage of green vehicles owned by a municipality. The average vehicle distance travelled per year is negative and statistically significant whether we controlled for self-selection or not. A 100-mile increase in the average distance travelled is associated with between 1.1 to 1.5 percentage point decrease in the percentage of municipally owned vehicles.

The second set of hypotheses had to do with the adoption of a food waste collection program by municipalities. We hypothesized that SEKOM membership increased the likelihood of adopting a food waste program, and that having a high level of non-food waste recycling (i.e., glass, paper, plastic, and metal) also increased the likelihood of adopting the food waste collection program.

We found significant evidence for both these hypotheses. Before controlling for self-selection, we find that compared to non—members SEKOM members are about 4.06 times more likely to adopt a food waste recycling program. After controlling for self-selection, we find that a 1 percentage point increase in the predicted probability of participation in SEKOM is associated with a 3 percent increase in the likelihood of adopting a food waste collection program. Per capita non-food recycling volume is associated with a higher likelihood of adopting a food waste collection program and this is true across all models. Each additional kilogram of non-food waste recycled is associated with between a 19 percent to a 36 percent increase in the likelihood of adopting a food waste collection program. This is a large effect given that the average per capita non-food waste recycling is around 10 kilograms.

The two stage estimation procedure accounts for self-selection bias, and controls for municipality specific characteristics. This approach does not however account for unobserved municipality and county characteristics that may vary over time. As a result, we are careful to frame our findings in terms of associations rather than causation.

Overall, our results suggest that that eco-municipality membership has a positive and significant effect on two specific environmental outcomes. SEKOM is an example of a public sector voluntary environmental program (VEP) that has succeeded in not just gaining widespread adoption, but also allowing local governments to improve their environmental performance in pursuance of Sweden's national environmental agenda. The adoption of similar public sector VEPs in other countries may be an important policy tool for improving the environmental performance of local governments.

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ARTICLE 3: THE EFFECT OF ECO-MUNICIPALITY MEMBERSHIP ON THE ADOPTION OF WIND POWER IN SWEDEN

3.1 Introduction

In 2017, the government of Sweden (through a parliamentary decision) committed to ensuring that 100% of Swedish electricity production be renewable by 2040 (Rskr 2017/18:411). This decision came from a recognition of the pivotal role that renewable energy sources have to play in climate change mitigation. In Sweden, wind power is a major component of the renewable energy mix. However, investments in wind power face a large number of economic, political, and institutional hurdles (Ek, Persson, Johansson, & Waldo, 2013; Pettersson & Söderholm, 2011).

One of the primary barriers to the adoption of wind power comes from the decentralized nature of the legal permitting procedures and planning systems that wind power is subject to. Municipalities have discretion on land use decisions. Since 2008 municipalities have had the authority to explicitly veto the development of wind power projects. In some cases, this veto was retroactively applied to pending applications. However, even before then local governments could indirectly oppose and delay the approval of development projects they were not in favor of. This was in part due to long lead times (often exceeding 4 years), and a lack of transparency in the decision criteria for approving projects (Soderholm, 2008). Even though the national government (through the Swedish Energy Agency) has designated certain areas as national interest areas for wind power (NIAW), this is a not a binding policy instrument. Where conflicts arise between renewable energy and other goals such as nature conservation, there are no guidelines on how to resolve such conflicts.

This paper will examine the impact of the National Association of Swedish Eco-municipalities (SEKOM), a Swedish public section Voluntary Environmental Program (VEP), on the adoption of wind power in Sweden. Eco-municipalities are local governments that have adopted ecological and social justice values as part of their charter. These municipalities take a systems level (across the board) approach to sustainable practices. For our purposes, a municipality will be considered to be an eco-municipality if it is a member of the National Association of Swedish Eco-municipalities (SEKOM) (Duma & Nilsson, 2022; James & Lahti, 2004).

We set out to answer two questions. The first was whether eco-municipality membership results in a greater adoption of wind power as measured by the number of operational wind power projects and installed capacity in megawatts (MW). The second was whether the length of exposure to the program had any effect on the adoption of wind power. This second question is motivated by the long lead time associated with wind power developments in Sweden.

Our results suggest that the answer for the first question is no. In our most restrictive models where we use matching to match each of the eco-municipalities to a similar non-member, membership does not have a statistically significant effect on the adoption of wind power. Next, we employ a series of robustness checks based on an estimation method by Callaway and Sant'Anna (2021) that overcomes the weaknesses of the two-way fixed effects (TWFE) estimator used in our baseline analysis. Again, we find no overall effect.

The answer for the second question is much more interesting. We find suggestive evidence that the treatment effect (membership) varies by the length of exposure to the program. The approach by Callaway and Sant'Anna (2021) allows us to disaggregate the treatment effects by cohort. We find that there is a positive effect for municipalities that have been exposed to the program for the longest period of time. Specifically, there is a positive and significant effect for the cohort of municipalities that joined SEKOM in 2004 and 2005 and have been exposed to SEKOM for 15 and 16 years respectively.

3.1.2 Research Questions

We are interested in answering the question of whether a municipality's environmental performance improves once they join SEKOM. SEKOM has mandatory reporting requirements for 12 key environmental outcomes such as heavy metal content in the water, percentage of renewable energy at the municipal premises, household waste, utilization rates for public transport, sustainable forestry/agriculture etc. Most of these measures are not suitable for our analysis as data is only available for the SEKOM members so in most cases there is no comparison group.

We will focus on whether membership affects the adoption of wind power as measured through the number of wind power projects, and the operational installed capacity in each municipality. This is a policy area that clearly aligns with SEKOM sustainability principles. Joining gives a municipality access to the SEKOM network where they can learn about the latest ecological innovations from existing members. In addition, the mandatory reporting requirements may put additional social pressure on local decisionmakers to attempt to improve environmental conditions.

Based on these arguments, our hypotheses are given below:

$\boldsymbol{H_1}$: Eco-municipality membership results in a greater adoption of wind power as measured by the number of operational wind power projects and installed capacity.

$\boldsymbol{H_2}$: The longer the exposure to the program, the larger the impact of membership on the adoption of wind power.

The remainder of this article is structured as follows: Section 3.2 provides a background on wind power investments in Sweden as well as a review of the literature on the effectiveness of voluntary programs. The data and empirical approach used in this article are described in Section 3.3 while results are presented in Section 3.4. Concluding remarks are provided in Section 3.5.

3.2 Related Literature

3.2.1 Wind Power in Sweden

The adoption of renewable sources of energy to mitigate the climate crisis is a very salient policy goal. There is a robust and ongoing policy debate in Sweden about the adoption of wind energy. The debate has to do with whether the discretion given to local governments to veto decisions relating to local land use should be limited. Local authorities have a substantial amount of discretion in influencing local planning processes. In cases where the benefits of wind power projects to the local economy are unclear, this makes their acceptance difficult and results in conflict between local goals and national energy policy goals[10].

In a 2011 report reviewing wind power planning and policy in Nordic countries, Pettersson and Söderholm (2011) estimated that wind power projects in Sweden had a lead time exceeding 4 years and that this was significantly larger than in neighboring countries such as Norway. As a result, the government has created a proposal that aims to simplify the wind power project approval process and limit the ability of municipalities to oppose individual projects. If enacted, the proposal would require municipalities to respond to inquiries from prospective wind power developers within nine months. In addition, any approvals granted would be legally binding for five years (SOU 2021:53).

Even though the financial support and incentives from the national government available for wind power are identical in all Swedish municipalities, there is a large amount of variation in

[10] Söderhamn, an eco-municipality in Central Sweden held a recent advisory referendum where voters resoundingly rejected plans for a 1GW offshore wind development. Note that Söderhamn is not included in our regression models as it joined SEKOM in 1998 which is well before the beginning of our sample period. (see www.windpowermonthly.com/article/1799326/voters-reject-skyborn-renewables-1gw-swedish-offshore-wind-plans)

the amount of operational installed wind power across the municipalities (Ek et al., 2013). Green certificates are the primary policy tool for incentivizing investment into renewable energy (RES-E). For every MWh of RES-E they generate, producers earn a certificate. These certificates constitute an additional source of income for the producers which encourages them to make renewable energy sources such as wind power a larger portion of their portfolio (Fridolfsson & Tangerås, 2013). Figure 3-1 shows geographic variation in the distribution of installed wind power capacity.

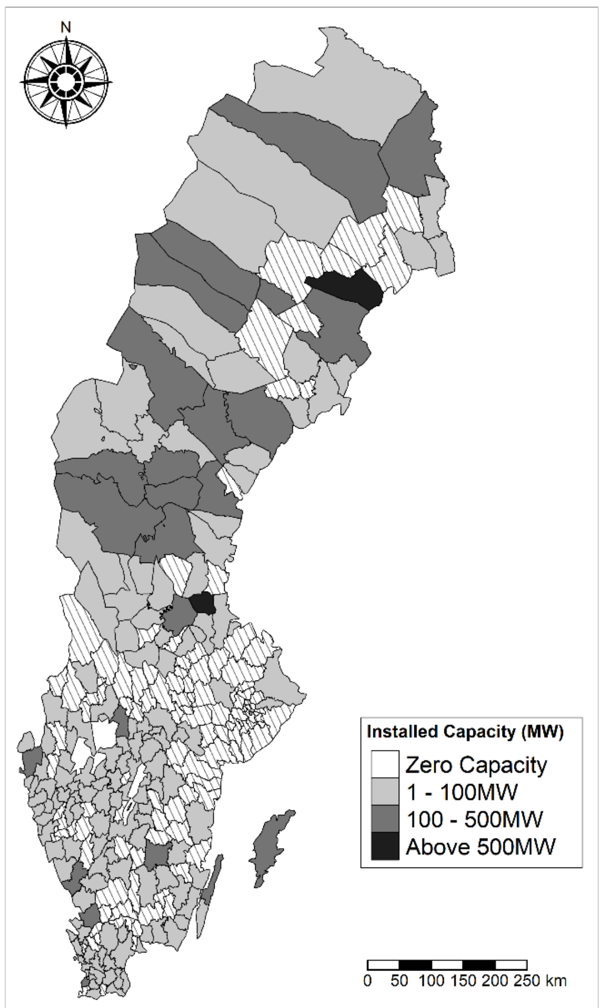

Figure 3-1: Total Installed Capacity in 2020

Local governments have the power to influence investment into wind farms both directly and indirectly. New developments are subject to local planning regulations. Beginning in 2008 municipalities have had the authority to explicitly veto the development of wind power projects. In some cases, this veto was retroactively applied to pending applications. However, even before then local governments could indirectly oppose and delay the approval of development projects they were not in favor of. This was in part due to long lead times, and a lack of transparency in the decision criteria for approving projects (Pettersson & Söderholm, 2011; Soderholm, 2008).

Since local governments have a lot of authority to influence the adoption of wind power, municipal characteristics are likely a factor in determining the variation in the adoption of wind power across Sweden. A study by Ek et al. (2013) examined this very question. One of the main determinants of installed capacity was whether the municipality contained areas classified by the Swedish Energy Agency as a national interest area for wind power (NIAW). They also found that population, and experience (in the first period up to 2005) were important determinants of installed capacity. They included an index for environmental quality which was not significant in both periods. We use many of the same variables used by this study to match each of the eco-municipalities in our sample to similar non-members. This is described in greater detail in Section 3.3.

Land use policy determines the locations at which wind turbines can be installed along with the design specifications (e.g., allowable heights and operating hours). In addition, land use policy details the criteria that need to be met before a permit for construction or the expansion of existing projects can be issued. Lauf et al. (2020) study local variation in the deployment of wind power across Sweden and Germany. Sweden has more decentralized land use policy than Germany. Lauf et al. make use of two dimensions of land use policy; special interest areas for wind power development, and nature protection areas. They argue that even though Sweden has areas designated as national interest for wind power, this designation is not a binding. Where there are conflicts between NIAW areas and other objectives such as nature conservation, the regulations provide no guidance on how such interests are to be weighed against each other. They consider the effect of variables such as population, size of region, wind speed, green party participation in government, the size of priority areas for wind power and nature protection.

Ek and Persson (2014) made use of a survey experiment to study the Swedish public's preferences related to the location, ownership, and cost characteristics of wind development projects. They had respondents select between two hypothetical projects with varying characteristics. Consumers were more willing to pay a higher RES-E fee for wind farms located outside recreational areas. Their willingness to pay was also higher when the wind farms were at least partially locally owned, and locals were included in the planning and implementation process. To the extent that they are aware of the preferences of their residents, local governments are likely to take them into account when deciding whether or not to grant permits for the construction of wind power.

3.2.2 Measuring the impact of Voluntary Environmental Organizations

There is some debate in the literature on whether VEPs work to improve environmental conditions, and how to measure their effectiveness. In attempting to understand the effectiveness and impact of voluntary environmental initiatives as policy tools we should not lose sight of the fact that these initiatives were never intended to replace more traditional regulatory instruments. Even as regulators have increasingly made use of voluntary initiatives, they continue to use them in concert with command-and-control and market-based regulations (U.S. EPA, 2010). Often regulator sponsored VEPs serve as a prelude to more comprehensive regulations. Overall, studies on the effectiveness of VEPs in improving VEPs have returned mixed results (Koehler, 2007). Whether or not a program has an impact depends on many program specific factors especially those relating to the presence of monitoring and enforcement mechanisms to prevent shirking.

Following Prakash and Potoski's (2006) argument, we consider two dimensions of effectiveness. The first one is that, for a voluntary initiative to be considered successful it should manage to recruit participants i.e., solve what Prakash and Potoski (2006) referred to as the Olsonian dilemma. The second dimension relates to improving environmental performance by ensuring that program participants do not shirk. It is easy to see that a voluntary program must succeed along both dimensions for it to be considered effective. For example, a program that results in significant environmental performance while having only a few members is not very policy relevant because it has very limited overall societal impact. By the same token, a program with a large membership but has no impact on performance is a greenwash that serves no purpose other than to give reputational benefits to its members. SEKOM has very clearly succeeded along the first dimension, an estimated 42% of Sweden's population live in an eco-municipality. We will attempt to find if in addition to this membership results in greater adoption of wind power.

Morgenstern and Pizer (2007b) conducted a review of the empirical literature on voluntary environmental programs in the United States, Japan, and Europe. They examine seven programs and find that all but one of the programs led to modest improvements in environmental performance with the effect size ranging from 5-28%. The programs covered a wide range of outcomes including toxic chemical releases, greenhouse gas (GHG) emissions, and energy use. The programs used various incentives to recruit members. These included giving members public recognition for their participation as well as providing technical assistance to help them improve their environmental performance. While acknowledging that VEPs do generate some environmental improvements, Morgenstern and Pizer conclude that it is unrealistic to expect such programs to serve as a long term substitute for formal regulation.

A study by Koehler (2007) has questioned the effectiveness of VEPs in improving environmental performance. The author argues that while early studies found VEPs to be effective, the results of recent studies conducted using more sophisticated methods are less encouraging. Activists opposed to voluntary initiatives argue that firm’s primary motivation for joining is to shield themselves from more stringent formal regulations with industry sponsored VEPs being the worst offenders. The monitoring and enforcement mechanisms of the program is the main factor determining whether VEPs result in improved performance (Prakash & Potoski, 2012). An analysis of the American Chemistry Council’s (ACC) Responsible Care program concluded that it did not result in an improvement of environmental performance. This was attributed to the lack of credible enforcement mechanisms (King & Lenox, 2000). On the other hand the ISO 14001 program which makes use of third party audits and its monitoring and enforcement mechanism was found to result in modest improvements in environmental performance (Potoski & Prakash, 2005).

In a study of public sector VEPs, Hughes (2012) evaluated an urban water conservation program in California where local governments and public agencies participated in a program whose goal was to reduce per capita water consumption in response to drought. Hughes found that local governments that joined the program did not reduce their water consumption. This suggests that even in cases where the VEP participants are local governments, VEPs must have credible monitoring and enforcement mechanisms if they are to be effective.

Finally, we will consider some of the methodological difficulties associated with trying to measure the effectiveness of VEPs. According to Morgenstern and Pizer (2007b), the chief difficultly is to distinguish between improvements in performance attributable to the voluntary programs and those that would have taken place anyway. Organizations are not randomly assigned into the program but they self-select. The ones that choose to participate are likely systematically different from those who do not. Membership may be endogenous with the same factors that influence the environmental improvement, so we need to control for this self-selection bias.

To account for this, we make use of two kinds of difference-in difference (DiD) research designs. In both cases we consider joining SEKOM to be the treatment with the join year treated as the last year of the pre-period. Each member of the treatment group is matched to a similar member of the control group so that any difference we observe between the two post-treatment can plausibly be attributed to the treatment. We make use of the standard two way fixed effects (TWFE) estimator as our baseline model, and then check our results for robustness using a more recent DiD estimator by Callaway and Sant'Anna (2021). The econometric methods are discussed in more detail in Section 3.3.2.

3.3 Data and Methods

3.3.1 Data Description

We collect our data from three sources: the Swedish Eco-municipality association (SEKOM), the Sweden Energy Agency, and Statistics Sweden. This section is divided into four subsections: The first describes the data sources and key variable definitions. The second describes the econometric methods used. The third subsection describes the matching procedure and provides tests for balance across the treatment and control groups. The final section tests whether the parallel trends assumption holds.

We will estimate the effect of SEKOM membership on two dependent variables. These are the number of installed wind energy plants, and the installed wind power capacity in megawatt hours for each municipality. In both cases we have data from 2003 to 2020. Beginning from a sample of all 290 of Sweden's municipalities, we drop municipalities with missing data and outliers and end up with a final sample ranging from 196 municipalities in the full sample, to a minimum of 81 municipalities in a subsample that includes only municipalities designated as National Interest Areas for Wind Power (NIAW) by the Swedish Energy Agency. These form balanced panel datasets ranging from 1,458 to 3,528 observations. The full data cleaning procedures are described in Appendix 3-A.

Table 3-1 describes the main variables and shows their sources.

Table 3-1: Variables and Data Sources

Variable	Definition	Data Source
Dependent Variables		
Number of wind farms	Number of operational wind farms in a municipality in a given year.	Sweden Energy Agency (2008)
Installed Capacity (mw)	Operational installed wind power capacity in mw.	Sweden Energy Agency (2008)
Key Independent Variable		
SEKOM membership	Binary variable for whether a municipality is a member of SEKOM in the current year.	SEKOM
Matching Variables		
Green Party votes	Vote share for the Green Party in the last election (%)	Statistics Sweden (2021)
Education	Percentage of the population with a college education	Statistics Sweden (2021)
Income	Average annual income (thousands SEK)	Statistics Sweden (2021)
Population	Population	Statistics Sweden
NIAW Area	The size of NIAW designed areas in square kilometers in a municipality.	Sweden Energy Agency (2008
NIAW	Binary variable for whether a municipality contains at least 1 NIAW.	Sweden Energy Agency (2008)
Coastline	Dummy variable for whether a municipality is on the coast.	Statistics Sweden (2021)

3.3.2 Econometric Methods

Our empirical strategy is a difference-in-difference (DiD) design. The canonical DiD consists of two periods (i.e., pre-treatment and post-treatment), two groups (treated and untreated), and treatment occurs at the same time for all members of the treatment group. However, our analysis has multiple time periods with treatment (i.e., joining the eco-municipality association) occurring in different years. The traditional approach to estimating treatment effects for DiD with multiple time periods has been to make use of two-way fixed effects (TWFE) regressions models see, Besley and Burgess (2004). This is the so-called staggered DiD which we could implement by running panel data regressions of the form:

$$Y_{it} = \alpha_i + \beta_t + \delta^{DD} D_{it} + \epsilon_{it} \tag{3.1}$$

where Y_{it} is the outcome measure for municipality i at time t, α_i is a municipality fixed effect, β_t is a year fixed effect, and D_{it} is the policy measure equals 1 for treated municipalities in the post-treatment period i.e., $D_{it} = Treatment_i \times Post_t$.

Recent econometric literature has raised concerns on some issues with TWFE DiD with staggered treatment timing (Baker, Larcker, & Wang, 2022; Goodman-Bacon, 2021). While the TWFE estimator (δ^{DD}) is robust to heterogeneous treatment effects (i.e., varying by unit and treatment time) in the two-period case, there are no such guarantees for the multi-period case. Goodman-Bacon (2021) demonstrate that δ^{DD} with staggered treatment timing is a weighted average of multiple treatment effects where the weights are not intuitive and can even be negative. As a result, δ^{DD} can yield estimates with the wrong magnitude and/or opposite sign compared to the true average treatment on treated (ATT). Given that a unit is from the treatment group, the

ATT is the difference between the outcome variable when the unit treated versus a counterfactual when it is not. i.e., $ATT = E[Y_1 - Y_0 | Treat = 1]$

We will instead adopt an approach by Callaway and Sant'Anna (2021) that allows us to:

- Estimate group-time treatment effects or cohort Specific effects: A group-time average treatment on treated effect is a unique estimated effect for a cohort of municipalities treated at the same point in time (i.e., municipalities that join SEKOM in the same year). These group time effects can be aggregated for easier interpretability, the weights for the aggregation depend on each cohort's sample share.
- Estimate dynamic treatment effects: These are treatment effects that are allowed to vary by the length of exposure to the program. The argument for this is that the treatment (policy intervention) may exhibit a lagged effect that becomes only apparent some years after the treatment.

Callaway and Sant'Anna (2021) created a difference-in-difference estimator that allows for multiple periods, treatment timing variation, and where a conditional (on the observable covariates) version of the parallel trends assumption holds. Following their notation; the estimated ATT is a function of the treatment group denoted as g, and the time period t. The group is defined by the treatment time (i.e., municipalities that joined in 2009 would be in a different group from those that joined in 2014). These group-time average effects are denoted as $ATT(g, t)$.

They begin by assuming that there are T periods where $t = 1, \ldots, T$, with a dichotomous variable D_{it} that is equal to 1 if the unit is treated at any point and 0 otherwise. G_g is defined to be a binary variable equal to 1 when the unit is first treated in period g, and C as a binary variable that is equal to 1 for never treated units. For each unit, exactly one of $\{G_1, \ldots, G_T\}$ or C is equal to

1. Denote the generalized propensity score as $p_g(X) = P(G_g = 1 | X, G_g + C = 1)$, which is the probability that an individual is treated conditional on having covariates X and conditional on being a member of a group g or a control group C (Baker et al., 2022; Callaway & Sant'Anna, 2021).

Callaway and Sant'Anna demonstrate that under these conditions, the group-time average effect can be denoted as[11]:

$$ATT(g,t) = \mathbb{E}\left[\left(\frac{G_g}{\mathbb{E}[G_g]} - \frac{\frac{p_g(X)C}{1-p_g(X)}}{\mathbb{E}\left[\frac{p_g(X)C}{1-p_g(X)}\right]}\right)(Y_t - Y_{g-1})\right] \quad 3.2$$

This procedure also allows us to have two control groups, one consisting of municipalities that were never treated (i.e., are still non-members at the end of the sample period), and another consisting of municipalities that are not yet treated. In addition, the estimation method provides test statistics for a conditional parallel trends assumption, which is an indirect way to test the parallel trends assumption of DiD designs.

3.3.3 Matching Procedure

Estimating causal effects from observational studies is a major challenge even when using quasi-experimental designs such as difference-in-difference. In our case, our treatment (SEKOM membership), is not randomly assigned, suggesting that any effect we observe post treatment may be the result of systematic differences between members and non-members that existed prior to the treatment. A commonly used method to reduce bias in similar observational studies is to match

[11] Callaway and Sant'Anna also authored an R Package that makes the estimation procedure very simple (see, Callaway, B., & Sant'Anna, P. (2021). did: Difference in Differences (Version R package version 2.1.1). Retrieved from https://bcallaway11.github.io/did)

each treatment unit to a similar untreated unit such that any differences between them post-treatment can plausibly be attributed to the treatment.

Propensity score matching (PSM) created by Rosenbaum and Rubin (1983) is perhaps the most commonly used method of matching. However, recent studies have raised concerns regarding its use. King and Nielsen (2019) demonstrate that in a large number of cases PSM achieves the opposite of its goal, sometimes increasing imbalance and model dependence. We will instead follow their recommendation and use Mahalanobis distance matching (MDM).

MDM pairs together observations that are close based on a measure called the Mahalanobis distance. The more dissimilar the covariate values, the larger the Mahalanobis distance. Observations with identical covariates will have a distance of zero. The goal is to find controls that are close to the treated units on the Mahalanobis distance, each matched pair will have similar covariate values, and the overall distribution of covariates will be similar across the treated group and the matched control group. PSM on the other hand, matches treated and untreated units on the estimated probability of being treated (also known as a propensity score) instead of matching on covariate values. Two matched units with similar propensity scores do not necessarily have similar covariate values. However, PSM can still yield balanced samples because of the theoretical balancing properties of the propensity score. Based on simulations they conducted across a wide range of settings, King & Nielsen (2019) critiqued PSM for increasing imbalance, model dependence, and bias.

The matching was conducted based on a set of variables that are associated with the location choices of wind farms. A study by Ek et al. (2013) looked at the determinants of installed wind power capacity across Swedish municipalities. They split the development of wind power in

Sweden into two periods (up to 2005 and post-2006). One of the main determinants of installed capacity in the post-2006 period (which is the bulk of our sample), was whether the municipality contained areas classified by the Swedish Energy Agency as a national interest area for wind power (NIAW). They also found that population, and experience (in the first period up to 2005) were important determinants of installed capacity. Finally, they included an index for environmental quality which was not significant in both periods.

The NIAW dummy variable serves as a proxy for how favorable the conditions in an area are for wind power production. In 2008 the Swedish Energy Agency designated certain parts of the country as national interest areas for wind power. This was based on their assessment of which areas had characteristics suitable for economically viable wind development projects. They considered areas with an average wind speed of at least 6.5 m/s with an elevation of 71 meters or higher.

Based on the study by Ek et al. (2013) we match on the following variables: percentage votes for the Green Party, percentage post-secondary education, population, average household income, municipality type (urban, rural, suburban), coastline, and NIAW designation. We performed exact matching for a subset of the covariates (NIAW, and coastline) that we reasoned were most the most important determinants of wind farm location choice.

Table 3-2 below shows the balance between the treatment and control groups on selected covariates before and after matching. The left side of the table shows the full unmatched data which consists of 196 municipalities, 46 are eco-municipalities and 150 are not. The right side of the table shows the same groups after matching. Each eco-municipality was matched to a non-member to make up a sample of 92 municipalities. The middle column shows the percentage improvement in balance after matching has occurred. Matching was conducted using the pre-period values of the covariates (i.e., 2003).

Table 3-2: Matching Summary Statistics

Variable	Full Data (N = 3,528)			Percent Reduction	Matched Data (N = 1,656)		
	Mean Treated	**Mean Control**	**eCDF Mean**		**Mean Treated**	**Mean Control**	**eCDF Mean**
Green Party	*4.73*	*2.97*	*0.143*	*52.1*	*4.73*	*3.46*	*0.068*
Education	*22.49*	*20.91*	*0.143*	*48.2*	*22.49*	*22.45*	*0.074*
Population	*30.12*	*26.58*	*0.148*	*46.0*	*30.12*	*30.38*	*0.080*
Avg Income	*193.15*	*189.29*	*0.103*	*59.9*	*193.15*	*193.41*	*0.042*
Rural	*0.50*	*0.45*	*0.053*	*-63.0*	*0.50*	*0.41*	*0.087*
Suburban	*0.28*	*0.40*	*0.117*	*44.4*	*0.28*	*0.35*	*0.065*
Urban	*0.22*	*0.15*	*0.064*	*66.1*	*0.22*	*0.24*	*0.022*
NIAW Area	*13.58*	*9.08*	*0.037*	*-5.8*	*13.58*	*11.62*	*0.039*
NIAW	*0.46*	*0.40*	*0.056*	*100.0*	*0.46*	*0.46*	*0.000*
Coastline	*0.52*	*0.19*	*0.328*	*100.0*	*0.52*	*0.52*	*0.000*

Notes:

1. *The left portion of each table provides results for the full, unmatched data, while the right portion displays results after matching has taken place.*

We make use of the eCDF statistics to evaluate the quality of the matching process. The eCDF shows how similar the distributions of the covariates are across the treatment and control groups. The statistic has a range from 0 to 1, with values closer to zero indicating better balance. Table 3-2 shows that matching reduces imbalance between the treatment and control groups for all the covariates except Rural and NIAW area which become slightly worse after matching. However, all our mean eCDF values are very close to zero which indicates good overall balance. We obtained exact matches for the coastline and NIAW designation variables. Based on this, the matching procedure appears to be successful, and we can proceed to the next stage.

3.3.4 Parallel Trends

One of the main identifying assumptions of the DiD design is that absent the treatment, the treated and control groups will evolve similarly in the future. The assumption requires that in the absence of treatment, the difference between the treatment and control group should remain constant over time. There is however no way to directly test this assumption. In practice, we can check for parallel trends prior to the treatment, with the assumption being that if the treatment had not occurred the parallel trend would have continued to hold in the post-treatment period. The most common method to check this assumption is to plot the trends in the response variable for the treatment and control groups. Since in our case the treatment occurs at different times, we standardize our time units and with the center being the SEKOM join date. For non-members in the control group, we allocate the same join date as the eco-municipality they were matched with.

We assume that treatment occurs at the end of the join year. Three periods were included in the pre/post treatment periods. The treatment represents all the municipalities that joined SEKOM between 2005 and 2017 (inclusive) and the control group is made up of those municipalities that were never treated i.e., never joined SEKOM. This window is narrower than our available data (2003 – 2020) so that we allow every municipality that we use for the pretrends plot to have at least three periods for its pre/post treatment periods. If we wanted to use a larger window for our pretrends test we would have to further restrict the join dates allowed in the sample making our sample smaller and less representative.

Figure 3-2 below shows the trends for the number of wind power plants dependent variable. It represents the aggregated data of 84 municipalities (out of the matched sample of 96).

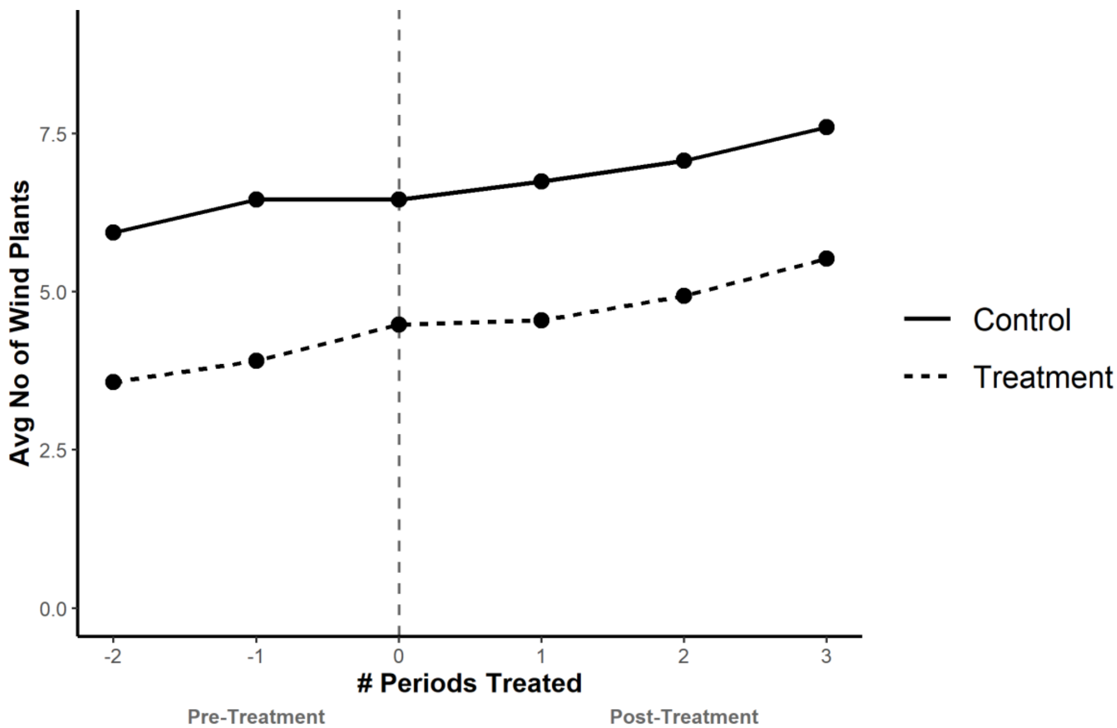

Figure 3-2: Parallel Trend Assumption – Number of Wind Power Plants

The trend in our response variable seems to be approximately parallel in the pre-treatment period continues to be so after the treatment. Visually, it does not appear that joining SEKOM has any effect on either direction on the adoption of wind power. Any effect, if it exists would have to be small.

In any event, it does appear that the difference between the treatment and control group is approximately constant before the treatment. In Section 3.4.2 we will augment this visual test with a statistical test for the conditional parallel trends assumption based on the Callaway and Sant'Anna approach.

We interpret our estimates as being causal. Conditional on the assumptions being satisfied, the estimates derived from quasi-experimental methods such as difference-in-difference (DiD) are widely regarded as causal in the economic literature. The matching procedure in Section 3.33

ensures that prior to the intervention, the treatment group is comparable to the control group. A visual inspection of Figure 3-2 suggests that the parallel trends assumption is satisfied. Our baseline model consists of a two-way-fixed-effects (TWFE) model which (at least in the two period case) is widely regarded as providing causal estimates (Besley & Burgess, 2004). We augment this with robustness checks based on the approach by Callaway and Sant'Anna (2021) whose results are widely regarded as causal in the multi-period case (Baker et al., 2022).

3.4 Regression Analysis and Results

We will begin in Section 3.4.1 by considering a set of baseline models that make use of the standard two-way fixed effects estimator for both matched and unmatched samples. In Section 3.4.2, we test our results for robustness using the framework by Callaway and Sant'Anna (2021) that allows us to estimate cohort specific effects[12].

3.4.1 Baseline Model

We estimate three models for both of our dependent variables. Each of the models is based on a subset of the data. The first is the "*No Matching (full sample)*" subset, this is simply the full sample after cleaning the data and removing outliers (see Appendix 3-A for additional details on the data preparation procedures). Here no attempt has been made to match the treated municipalities (SEKOM members) to similar municipalities in the control group. We instead use the matching covariates as controls in a standard TWFE regression.

The second is the "*No Matching (NIAW only)*" sample. Similar to the first subset, no matching attempt has been made. Instead, it is a subset of the full sample where we consider only those municipalities that have the NIAW designation. The third and final subset is one where

[12] This is discussed in more detail in Section 3.3.2: Econometric Methods.

Mahalanobis distance matching was used to match each of the 46 eco-municipalities to 46 similar non-members.

Table 3-3 shows the results of the baseline models estimating the impact of SEKOM membership on wind power adoption. The set of columns on the left shows the results for the number of wind farms variables, and the one on the right to the installed capacity variable.

Table 3-3: Baseline Model - Impact of SEKOM membership on Wind Power Adoption

	Number of Wind Farms			***Installed Capacity (MW)***		
	No Matching (full sample)	*No Matching (NIAW only)*	*Matching*	*No Matching (full sample)*	*No Matching (NIAW only)*	*Matching*
ATT	*0.77******	*0.94**	*0.49*	*1.49****	*2.52**	*0.98*
	(0.30)	*(0.50)*	*(0.32)*	*(0.65)*	*(1.31)*	*(0.67)*
Constant	*-1.15*	*-28.11******	*-3.16******	*-2.36*	*14.33*	*-5.83******
	(1.68)	*(5.32)*	*(0.70)*	*(3.97)*	*(9.33)*	*(1.37)*
Observations	*3,528*	*1,458*	*1,656*	*3,528*	*1,458*	*1,656*
SEKOM (Yes/No)	*46/150*	*21/60*	*46/46*	*46/150*	*21/60*	*46/46*
Controls	*Yes*	*Yes*	*No*	*Yes*	*Yes*	*No*
Adjusted R^2	*0.799*	*0.781*	*0.815*	*0.621*	*0.637*	*0.653*

Notes:

1. ****, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.*
2. *Huber-White standard errors clustered at the municipality level are in parentheses.*
3. *Municipality/Year dummy variables omitted.*
4. *For the unmatched samples, all the matching covariates are used as controls.*

For both of our dependent variables, we only obtain statistically significant results for the unmatched samples. The more restrictive models where each eco-municipality was matched to a similar non-member all turned out to be insignificant. The results for the NIAW sample are only marginally significant at the 10% level.

We begin by discussing the models for the number of wind farms dependent variable. For the full sample (unmatched) the estimated average treatment effect on the treated (ATT) effect is 0.77 and is significant at the 1% level. This can be interpreted to mean that SEKOM membership results in a 0.77 increase in the number of wind farms in a municipality. The effect of the NIAW sample is 0.94 which is only significant at the 10% level.

The results for the installed capacity dependent variable are very similar. Both the unmatched models are statistically significant with the effect of membership ranging on installed capacity ranging from 1.49 to 2.52 MW. Once we use the more restrictive model with the matched sample, there does not appear to be any effect.

However, these results must be taken with caution. As we discussed in Section 3.3.2, under staggered treatment timing, the TWFE estimator is a weighted average of many different treatment effects with the weights often negative and non-intuitive. In the next section, we will use an alternative approach to test our results for robustness.

3.4.2 Robustness Checks

In this section we utilize an approach pioneered by Callaway and Sant'Anna (2021) to overcome some of the problems associated with the two-way fixed effects (TWFE) models we used for the baseline analysis. The method allows us to disaggregate the ATT into group-time effects as well as to figure out whether the effects vary by number of periods treated (i.e., the so-called event study analysis).

We begin by estimating group-time effects. These are then aggregated as there is a large number of groups[13]. Table 3-4 shows the aggregated group-time effects along with tests for statistical significance. Unlike the TWFE estimator where the weights of the effect sizes are unknown, here the weights for the aggregated group-time effect are based on the size of each group/cohort.

Just as in the baseline models, we estimate two sets of models one set for each dependent variable. All the models make use of the matched dataset. For each dependent variable we run one model where the control group is the municipalities that were *never treated* (i.e., are still non-members in the final period), and those that are *not yet treated* (i.e., not members in the current period).

The R implementation of the Callaway and Sant'Anna estimator comes with an integrated moments test for the conditional parallel trends assumption holding in all pre-treatment time periods for all groups (Callaway & Sant'Anna, 2021). This is an imperfect test of the DiD parallel trends assumption but is a useful tool to complement the visual test we conducted in Section 3.3.4. It tests the null hypothesis that the conditional parallel trends assumption holds. The conditional parallel trends assumption holds across all the models.

[13] There are 13 groups (i.e., at least 2 municipalities joined SEKOM in 13 out of the 18 years in our sample), and 18 time periods. This results in over a hundred estimated group-time effects. Only the aggregated effects are reported.

Table 3-4: Robustness Check - Impact of SEKOM membership on Wind Power Adoption

	Number of Wind Farms		**Installed Capacity (MW)**	
	Ctrl: Never Treated	*Ctrl: Not Yet Treated*	*Ctrl: Never Treated*	*Ctrl: Not Yet Treated*
ATT	*1.053*	*1.028*	*2.617*	*2.513*
	(0.784)	*(0.755)*	*(1.692)*	*(1.651)*
Observations	*1,656*	*1,656*	*1,656*	*1,656*
SEKOM (Yes/No)	*46/46*	*46/46*	*46/46*	*46/46*
P-value *PTA*	*0.327*	*0.422*	*0.323*	*0.347*

Notes:

1. ****, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.*
2. *Huber-White standard errors clustered at the municipality level are in parentheses.*
3. *Municipality/Year dummy variables omitted.*

All the aggregated group time effects are not statistically significant. This matches the results of the matched sample in our baseline analysis. Next, we test for dynamic (time varying) effects. One argument that we can make is that the effect becoming an eco-municipality may depend on the length of exposure to the program. This is plausible given the very long lead times for wind development projects in Sweden. The approach by Callaway and Sant'Anna allows us to estimate what they refer to as dynamic treatment effects i.e., where the treatment effect is allowed to vary based on the length of exposure to SEKOM.

Figure 3-3 shows the ATT by length of exposure for the number of wind farms dependent variable. The horizontal axis shows the number of years of exposure to the program (years since joining). The negative values show the pre-period, and the positive ones show the post-treatment period. The pre-period serves as a placebo test because we should not see any program impacts before the treatment.

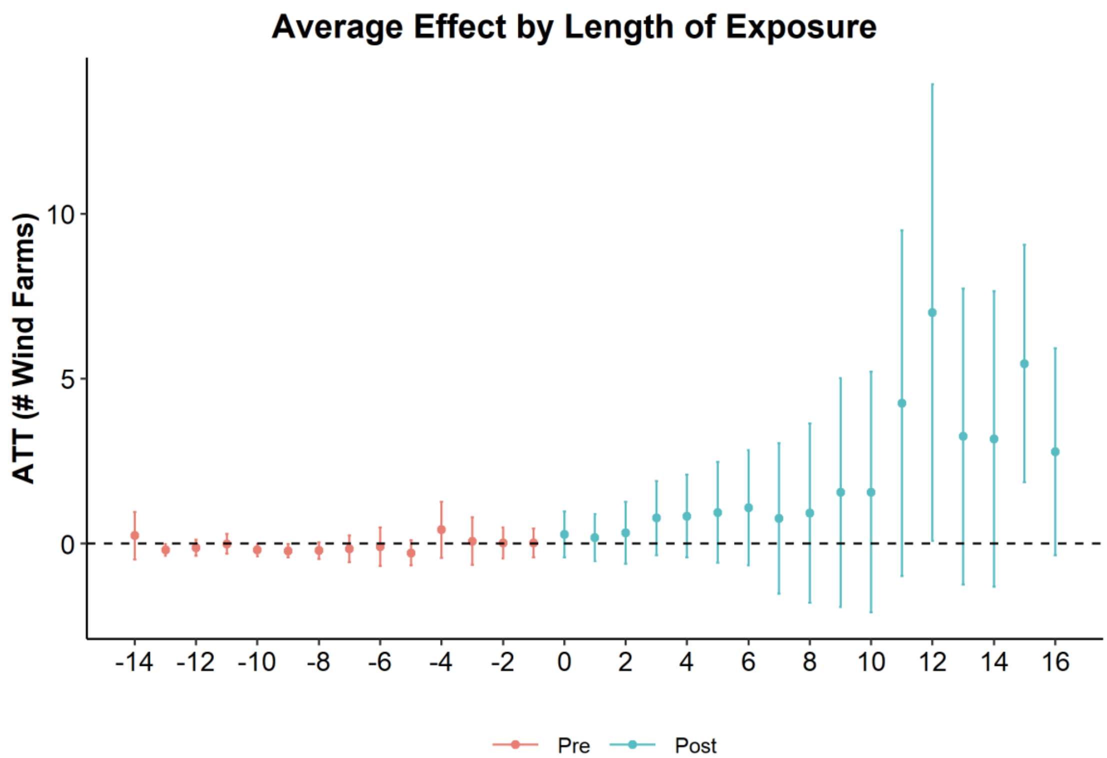

Figure 3-3: Impact of SEKOM Membership on the number of Wind Farms - By Length of Program Exposure

In line with our expectations, the entire pre-treatment period is not statistically significant. However, the only statistically significant effect we observe is for the 15 years of exposure (i.e., municipalities that joined in 2004). The overall aggregated dynamic effect is also not statistically significant.

Figure 3-4 shows the ATT by length of exposure for the number of installed wind power capacity dependent variable.

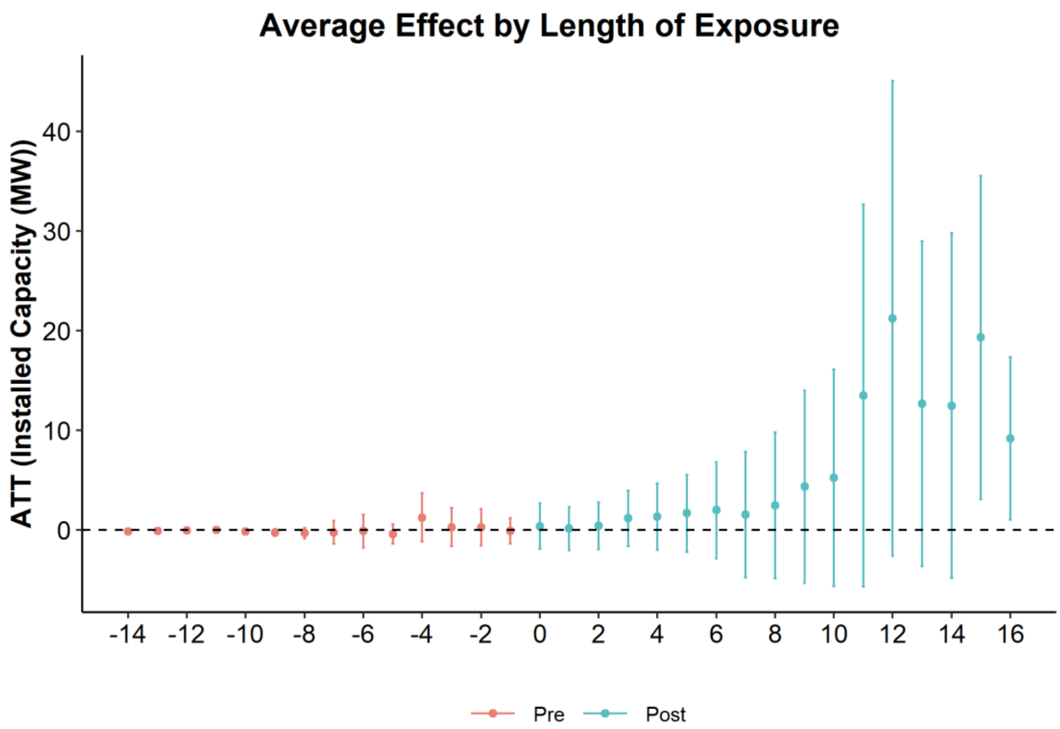

Figure 3-4: Impact of SEKOM Membership Installed Capacity - By Length of Program Exposure

Again, we find that as expected, the entire pre-treatment period is not statistically significant. The only significant ATTs were for the municipalities exposed for the longest periods (15 and 16). These are ones that joined SEKOM in 2004 and 2005 respectively. Unlike the wind farm event study, here the average dynamic effect is statistically significant at the 5% level. On average joining SEKOM increases installed wind capacity by 6.4 MW, this is a larger effect than we obtained from the unmatched samples in the baseline analysis (1.49 – 2.52 MW).

Overall, the results are suggestive but not conclusive. The effect sizes in the pre-period are insignificant for both models which serves as a placebo check. In addition, the effect sizes in the post-period although largely insignificant are larger than those for the pre-period and appear trend upwards the longer the exposure to the program. Finally, the only significant ATTs are for the cohorts that have been exposed to the treatment for the longest period. Table 3-6 in Appendix 3-C shows the full results for the event study.

What all of this suggests is that SEKOM membership likely has a positive effect on the adoption of wind power, but any such effect takes a long time to be felt. It could also imply something about the characteristics of the municipalities that are members of the 2004 and 2005 cohorts[14]. To eliminate the possibility that the significant result we observe for the earliest cohort could be due to imbalance on the matching covariates we compare the summary statistics of that cohort against the rest of the sample (broken up by treated and not treated). The results presented in Table 3-7 in Appendix 3-D suggest that the significant cohort is balanced with the untreated group on the matching covariates. This, however, does not exclude the possibility that the effects we observe could be attributable to some unobserved characteristic of the members of the earliest cohorts.

3.5 Conclusions

We set out to answer two main questions: The first was whether eco-municipality membership results in a greater adoption of wind power as measured by the number of operational wind power projects and installed capacity. The second was whether the length of exposure to the program had any effect on the adoption of wind power.

Our results for the first question are mixed. In our least restrictive models where we compare SEKOM members to all non-members we find that membership has a positive and statistically significant effect on the adoption of wind power. However, once we use matching to match each of the eco-municipalities to a similar non-member, the effect stops being significant. The robustness check using the Callaway and Sant'Anna estimator was similarly insignificant. Our

[14] The municipalities that joined in 2004 and 2005 are Kramfors, Robertsfors, Härnösand, and Kungsbacka. All except one of them are NIAW designated.

overall conclusion is that since the most restrictive models were insignificant, there likely is no overall effect.

The results for the second question are more interesting. When we test for dynamic (time varying) treatment effects, we find that SEKOM membership has a positive and significant overall effect on the installed wind power capacity. On average, membership increases installed capacity by 6.4 MW. In addition, for both the number of wind power projects and installed capacity we find that the municipalities that have been exposed to the program for the longest periods (15 and 16 years) have the only significant effects. There are several potential interpretations here: The first is that SEKOM membership has a delayed (long term) effect on the adoption of wind power.
A second interpretation is that perhaps the observed effect has less to do with the length of exposure and more to do with some characteristics of the specific members of the earliest cohorts. Although we used matching to create a comparable control group, we can only match on observables, and there may exist some unobserved (unaccounted for) variables that differ significantly between the treatment and control groups and are also related to the adoption of wind power.

A prediction of the first interpretation is that a future study with the opportunity to extend the dataset into the future should observe larger effects with the ATTs for more and more cohorts rising to the level of statistical significance. Our tentative conclusion is that while there is no evidence of an overall effect, eco-municipalities may have a long term effect on the adoption of wind power. The longer the exposure to the treatment, the larger and more significant the measured effects.

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Appendix 3-A: Data Trimming

This appendix describes the data cleaning procedure for the each of the datasets used for the analysis. We began with a sample of all 290 Swedish municipalities for the years 2003- 2020 for which we have wind power data. We first drop six municipalities for which the SEKOM join date is unknown, we then drop 15 municipalities that joined and subsequently left SEKOM within our sample period, and Knivsta municipality which was only created in 2003. This leaves us with a total of 268 municipalities of which 96 are members and 172 are non-members.

The next step was to only keep those members that joined between 2003 and 2019. This was done so that all the municipalities in our analysis would have at least one pre and post treatment period. This reduces the sample to 223 municipalities (51/172 members/non-members).

Once this was done, we removed outliers using the standard Tukey ($Q + 1.5IQR$) rule. The list of outliers is given in Appendix 3-B. The sample after the reduction is 46/150 members to non-members. We use this final sample to create our three analysis datasets which can be described as follows:

1. **Matched Dataset:** The 46 remaining members were each matched to a similar non-member using Mahalanobis distance matching to create a dataset of 46/46 members/non-members which adds up to 1,656 observations.
2. **Full Unmatched Dataset:** The full dataset after cleaning without any matching. 46/150 members/non-members which adds up to 3,528 observations.
3. **Unmatched Dataset (NIAW only):** The unmatched dataset but only for municipalities that are designated as National Interest Areas for Wind Power by the Swedish Energy Agency. 21/60 members/non-members which adds up to 1,458 observations.

Appendix 3-B: Outliers

This table shows the outliers dropped from the analysis as described in Appendix A. In addition, it shows whether or not they are SEKOM members during the final year in our sample, and whether they have an NIAW designation from the Swedish Energy Agency. Almost all the outliers are non-members and have an NIAW designation.

Table 3-5: List of Outliers Removed

	Municipality	***SEKOM Member***	***# Wind Plants***	***Installed Capacity (MW)***	***NIAW***
1	Piteå	*No*	*280*	*894*	*Yes*
2	Ockelbo	*Yes*	*182*	*634*	*Yes*
3	Strömsund	*No*	*153*	*431*	*Yes*
4	Örnsköldsvik	*Yes*	*128*	*361*	*Yes*
5	Sundsvall	*Yes*	*89*	*320*	*Yes*
6	Malå	*No*	*74*	*150*	*Yes*
7	Ljusdal	*Yes*	*73*	*240*	*Yes*
8	Vetlanda	*No*	*62*	*169*	*Yes*
9	Tanum	*No*	*60*	*105*	*Yes*
10	Kristianstad	*No*	*59*	*98*	*Yes*
11	Storuman	*No*	*59*	*146*	*Yes*
12	Kristinehamn	*No*	*57*	*211*	*Yes*
13	Vara	*No*	*56*	*87*	*No*
14	Ånge	*Yes*	*56*	*241*	*Yes*
15	Härjedalen	*No*	*54*	*132*	*Yes*
16	Malmö	*No*	*51*	*114*	*No*
17	Falun	*No*	*51*	*172*	*Yes*
18	Bräcke	*No*	*48*	*138*	*Yes*
19	Åsele	*No*	*45*	*89*	*Yes*
20	Gällivare	*No*	*42*	*122*	*Yes*
21	Nordmaling	*No*	*41*	*94*	*Yes*
22	Berg	*No*	*41*	*115*	*Yes*
23	Pajala	*No*	*40*	*137*	*Yes*
24	Östersund	*No*	*35*	*92*	*\Yes*
25	Skellefteå	*No*	*30*	*115*	*Yes*
26	Mariestad	*No*	*29*	*83*	*No*
27	Ragunda	*No*	*26*	*92*	*Yes*

Appendix 3-C: Robustness Check – Event Study

This table shows the companion data for Figure 3-4 in Section 3.4.2. It shows dynamic treatment effects of the impact of SEKOM membership on the wind power installed capacity. The event time represents the number of years of exposure to the treatment. Negative values of event-time show the years before the treatment. The estimates for the negative event times also serve as a placebo test because we would not expect to see statistically significant estimates before the treatment has occurred.

Only the two longest exposure times (15 and 16 years) are statistically significant at the 5% level. These represent municipalities that joined SEKOM in 2004 and 2005 and have been exposed to the program for the longest period

Table 3-6: Event Study - Impact of SEKOM membership on Installed Capacity by Length of Exposure

Event Time	*Estimate*	*Std. Error*	*95% CI - LB*	*95% CI - UB*
-14	*-0.174*	*0.08*	*-0.375*	*0.027*
-13	*-0.139*	*0.076*	*-0.331*	*0.053*
-12	*-0.065*	*0.124*	*-0.379*	*0.248*
-11	*-0.034*	*0.102*	*-0.291*	*0.223*
-10	*-0.179*	*0.087*	*-0.399*	*0.041*
-9	*-0.279*	*0.129*	*-0.604*	*0.047*
-8	*-0.343*	*0.205*	*-0.86*	*0.173*
-7	*-0.254*	*0.438*	*-1.358*	*0.85*
-6	*-0.127*	*0.663*	*-1.796*	*1.543*
-5	*-0.412*	*0.385*	*-1.382*	*0.557*
-4	*1.231*	*1.027*	*-1.355*	*3.818*
-3	*0.265*	*0.758*	*-1.645*	*2.174*
-2	*0.228*	*0.768*	*-1.706*	*2.163*
-1	*-0.103*	*0.533*	*-1.446*	*1.24*
0	*0.364*	*0.924*	*-1.964*	*2.692*
1	*0.133*	*0.888*	*-2.104*	*2.37*
2	*0.397*	*1.000*	*-2.123*	*2.916*
3	*1.138*	*1.216*	*-1.924*	*4.2*
4	*1.317*	*1.365*	*-2.122*	*4.755*
5	*1.664*	*1.634*	*-2.451*	*5.78*
6	*1.975*	*1.85*	*-2.685*	*6.636*

7	*1.517*	*2.496*	*-4.77*	*7.804*
8	*2.454*	*3.02*	*-5.152*	*10.06*
9	*4.341*	*3.852*	*-5.361*	*14.044*
10	*5.197*	*4.052*	*-5.008*	*15.403*
11	*13.475*	*7.359*	*-5.06*	*32.009*
12	*21.217*	*9.429*	*-2.531*	*44.966*
13	*12.652*	*6.805*	*-4.488*	*29.792*
14	*12.465*	*6.068*	*-2.819*	*27.749*
15	*19.293****	*5.364*	*5.783*	*32.804*
16	*9.152***	*3.121*	*1.29*	*17.014*
Overall ATT	***6.397*****	***2.687***	***1.130***	***11.664***

Note: ****, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.*

Appendix 3-D – Significant Cohort Summary Statistics

This section takes a closer look at the significant result we obtained for the dynamic treatment effects. When we computed the treatment effects by the length of exposure, we found significant results for the cohorts that have been exposed to the treatment for the longest time (15 and 16 years). The members of this cohort are the eco-municipalities Kramfors, Robertsfors, Härnösand, and Kungsbacka which all joined in 2004 and 2005.

Table 3-7 below shows the summary statistics across a range of variables for the significant cohort compared to treated and untreated observations in the rest of the sample. We test for differences in means between the treated/untreated groups and the significant cohort.

Table 3-7: Summary Statistics - Significant Cohort vs Rest of Sample (Treated/Untreated)

Variable	***Significant Cohorts***	***Treated (rest of the sample)***	***Control (rest of the sample)***
Number of Plants	*5.40*	*5.90*	*4.65*
Installed Capacity (MW)	*11.54*	*10.45*	*5.43****
% Votes Green Party	*4.44*	*5.45****	*4.53*
% Post-Secondary Educ	*27.66*	*29.76***	*26.25*
Avg Income (000 SEK)	*245.01*	*276.10****	*239.39*
Population (000)	*31.78*	*35.73*	*31.46*
% Coastline	*1.00*	*0.45*	*0.51*
% Rural	*0.50*	*0.52*	*0.44*
% Suburban	*0.25*	*0.30*	*0.32*
% Urban	*0.25*	*0.18*	*0.24*

Note:

1. ****, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively.*
2. *The statistical tests are for differences between the treated/untreated groups and the significant cohort.*

There are no differences between the significant cohort and the rest of the untreated sample except for one of the dependent variables (Installed Capacity). This indicates that this sample is balanced with the untreated group on the matching variables. The significance of the dependent variable is consistent with our estimation results which suggest that the treatment increased the installed capacity for members of this cohort. There are several differences between the significant cohort and the rest of the treated units. Specifically, the significant cohort has lower green party votes, education, and income compared to the rest of the treated units. Based on the summary statistics, it appears that the significant dynamic effect of the earliest cohorts cannot be attributed to imbalance in the matching process.

OVERALL CONCLUSION

In this dissertation we consider Sweden's Eco-municipalities as an instance of a national-level public voluntary environmental program (VEP). We ask two classes of questions both of which relate to the National Association of Swedish Eco-municipalities (SEKOM). The first class has to do with the reasons why municipalities would voluntarily opt to join a VEP such as SEKOM. This was the subject of the first article. The second class of questions had to do with whether membership improved the environmental performance of municipalities which is the subject of Articles 2 and 3.

In the first article, using a probit model that accounts for the spatial dependence in our data, we find that environmental consciousness (as proxied by share of votes for the Green Party), level of education, the municipality being suburban, and environmental vulnerability (as proxied by proximity to the coast) are positively associated with program membership. The employment share in heavy industry was negatively associated with program membership. Other municipal attributes such as average age, population, average household income, and foreign-born residents turned out to be insignificant in explaining membership in SEKOM.

We make the argument that municipal attributes alter the balance of the costs versus benefits of joining SEKOM. For example, a municipality with a large share of employment in heavy industry would be reluctant to join an organization such as SEKOM which has mandatory reporting requirements of various measures of environmental performance. Such a municipality faces a tradeoff of environmental versus economic values such that implementing the environmental measures associated with SEKOM members may present an unacceptably high economic cost. As a result, the cost of joining is higher for regions which are economically reliant on heavy industry which could reduce their likelihood of participation. This example shows how a municipal attribute can influence the cost of program participation.

Municipal attributes can also influence the benefits of joining. Coastal areas present additional challenges in terms of environmental protection that are not faced by non-coastal municipalities. Because of this, municipalities with a coastline may have more to gain from joining an association such as SEKOM. Municipalities with more educated environmentally conscious residents may obtain greater signaling value to their residents by joining SEKOM which would increase the benefits of joining.

The second article examines the effects of SEKOM membership on environmental performance as measured by two variables: The percentage of municipally owned Environmentally Classified Vehicles (ECVs), and the adoption of a food waste recycling program by the municipality. These variables were selected because they are factors that are under the control of the local government and could thus be plausibly affected by joining SEKOM. After controlling for self-selection, a 1 percentage point increase in the predicted probability of participation in SEKOM is associated with between 0.102 and 0.143 percentage point increase in the share of green vehicles owned by a municipality.

Additionally, we find that average vehicle distance travelled per year is negatively associated with the adoption of green vehicles. This effect is statistically significant with a 100-mile increase in the average distance travelled associated with between a 1.1 to 1.5 percentage point decrease in the percentage of municipally owned green vehicles. One interpretation is that, because range concerns are a main barrier towards the adoption of electric vehicles (a subset of green vehicles), municipalities where travel distances are routinely large may be reluctant to acquire a large number of green vehicles. As a check for this hypothesis, we also test whether the range anxiety effect is stronger in the later years of our sample where electric vehicles are a much larger proportion of the ECV category, we find this to be the case.

We also found that SEKOM membership was positively associated with the adoption of food waste collection policy. After controlling for self-selection bias, a 1 percentage point increase in the predicted probability of SEKOM membership is associated with a 3 percent increase in the likelihood of adopting a food waste collection program. This is a substantively large effect. Per capita non-food recycling volume is associated with a higher likelihood of adopting a food waste collection program and this is true across all models. Each additional kilogram of non-food waste per capita recycled is associated with between a 19 percent to a 36 percent increase in the likelihood of adopting a food waste collection program. This is a large effect given that the average per capita non-food waste recycling is around 10 kilograms.

The third article examines the effect of SEKOM membership on the highly contentious wind power policy in Sweden. We set out to answer two questions. The first was whether eco-municipality membership results in a greater adoption of wind power as measured by the number of operational wind power projects and installed capacity in megawatts (MW). The second was whether the length of exposure to the program had any effect on the adoption of wind power. This second question is motivated by the long lead time associated with wind power developments in Sweden.

Our results suggest that the answer for the first question is no. SEKOM membership does not have a statistically significant overall effect on the adoption of wind power even after we augment our baseline model (Two Way Fixed -Effects (TWFE)) with a series of robustness checks based on an estimation method by Callaway and Sant'Anna (2021).

The answer for the second question is much more interesting but still not conclusive. We find suggestive evidence that the treatment effect (membership) varies by the length of exposure to the program. The approach by Callaway and Sant'Anna (2021) allows us to disaggregate the treatment effects by cohort. We find that there is a positive effect for municipalities that have been exposed to the program for the longest period of time. Specifically, there is a positive and significant effect for the cohort of municipalities that joined SEKOM during the earliest years in our sample.

The primary contribution of our study is to provide a detailed view of a regional public sector voluntary environmental program (VEP) that takes a systems level bottom-up participatory decision-making approach to sustainability. We begin by examining the factors that determine the decision to participate in the program and then proceed to demonstrate that SEKOM membership does improve municipal environmental performance for some measures. The fact that SEKOM appears to influence the adoption of Environmentally Classified Vehicles (ECVs), and food waste collection policy but not wind power adoption is also very informative. It suggests that it is more difficult to *move the needle* for some environmental issues than others. Wind power is a highly contentious policy issue in Sweden with conflict between local goals (e.g., economic development in form of tourism) and national energy policy goals. On the other hand, green vehicles and food waste collection are less controversial and relatively easy to improve on.

The policy relevance of all of this is clear. Sweden's eco-municipality association is a VEP/green club that has succeeded in tackling the Olsonian dilemma with its membership constituting almost a third of Sweden's 290 municipalities. Our results suggest that in addition to this, the program also improves on some measures of environmental performance. This places it in a position to make a significant societal impact. The idea of bottom-up participatory decision making that follows SEKOM's general principles has spread to municipalities in places like Norway, the Northeastern United States, and has served as a model for the Rio Declaration on Environment and Development (Agenda 21). Our results here will likely generalize to similar voluntary initiatives.

As a parting note, we will discuss the limitations of this study with a view towards identifying future research directions. The main limitations relate to external validity. We noted previously that our research is likely to generalize to similar settings, it must be noted however that Sweden differs from many countries in several respects. Sweden has very high levels of environmental concern. Locales with lower environmental concern may be less likely to join VEPs or more likely to shirk when they do. In addition, Sweden has highly decentralized decision making for local governments. Local governments in other countries may not have the autonomy to affect environmental outcomes even if they join VEPs. This concern could be addressed in future research by investigating eco-municipalities in other locations such as the Northeastern U.S. (Wisconsin, New Hampshire, and Minnesota) to see if the results generalize. One tentative result we obtained was that the length of exposure to SEKOM appeared to influence the adoption of wind power. Another future avenue of research would be to repeat the same analysis but with a longer time series to rule out the possibility that the result was due to a small sample.