

Evaluating the Regional Development Effects of Wind Power Expansion in Sweden

Pietro Faccioli

Supervisor: Elina Lampi

Master's thesis in Economics, 30 hec

Spring 2026

Graduate School, School of Business, Economics and Law, University of Gothenburg, Sweden



UNIVERSITY OF GOTHENBURG

SCHOOL OF BUSINESS, ECONOMICS AND LAW

Evaluating the Regional Development Effects of Wind Power Expansion in Sweden

Pietro Faccioli

Abstract

This study examines the development effects of wind power expansion in Sweden at the municipal level from 2003 to 2024. Using a municipality–year panel dataset, it investigates whether there are measurable gains and how they differ across municipalities, whether there are any effects on intramunicipal inequality, and if there are effects on the local employment structure. The analysis showed that wind power expansion is associated with a statistically significant, but negative effect on average municipal income; the effect is heterogeneous across municipalities that differ in population density, average income, and geographical location. On the other hand, there is little to no evidence of any effects on within-municipality inequality or on the municipal employment structure. These findings provide valuable insights for policymakers by suggesting that expanding wind power capacity alone is insufficient to simultaneously achieve environmental and economic objectives. Instead, policies should account for local conditions and distributional mechanisms to ensure that the green transition is both efficient and inclusive.

Keywords: Wind power expansion, municipal income, income inequality, labor market, Sweden, panel data

Acknowledgments

I would like to express my sincere appreciation to my supervisor, Elina Lampi, for her support and guidance throughout the process of writing this thesis. Her valuable comments, constant feedback, and regular meetings helped me refine and improve this thesis immensely. I would also like to thank my co-supervisor, Polina Karpaty, of the National Institute of Economic Research (Konjunkturinstitutet), whose feedback and discussions were also invaluable throughout the work on this thesis. Last but definitely not least, I would like to thank my family and my partner for their continuous encouragement, patience, and unwavering support throughout this journey, even if far away.

AI Disclosure

Disclosure: AI has been used to enhance the clarity and readability of the text by correcting grammatical errors and improving sentence structure.

Table of Contents

1. Introduction **1**
2. Background: Wind Power Expansion and Municipal Economic Exposure in Sweden **4**
2.1 The expansion of Wind Power in Sweden 4
2.2 The Municipal Governance Framework and the Veto Power 6
2.3 How Municipalities Gain (or Do Not Gain) 7
2.4 Why Wind Power May Affect Inequality 8
3. Previous Literature **9**
3.1 Local Economic Impacts of Wind Power Development in the World 9
3.2 Local Economic Impacts of Wind Power Development in Sweden 11
3.3 Swedish institutional and policy context 12
3.4 Distributional and Social Consequences 13
3.5 Synthesis and Gaps in the Literature 14
3.6 Conclusion of the Literature 14
4. Theoretical Framework **14**
4.1 Wind Power as a Place-Based Economic Shock 15
4.2 Agglomeration and Heterogeneous Local Effects 16
4.3 Distributional Effects and Local Inequality 16
4.4 Structural Change and Employment Composition 17
5. Empirical Strategy **18**
5.1 Municipal Gains and Heterogeneous Effects of Wind Power (Hypothesis 1) 19
5.2 Municipal Income Inequality Effects of Wind Power (Hypothesis 2) 20
5.3 Local Labor Market Effects of Wind Power (Hypothesis 3) 21
6. Data **22**
6.1 Data Structure and Type 23
6.2 Municipality Characteristics and Descriptive Statistics 24
7. Results **26**
7.1 Selection into Wind Power Adoption 26
7.2 Results for Hypothesis 1: Municipal Gains and Heterogeneity 26
7.3 Results for Hypothesis 2: Income Inequality 32
7.4 Results for Hypothesis 3: Labor Market Effects 33
8. Discussion and Policy Implications **35**
8.1 Discussion 35
8.2 Policy Implications 37
9. Conclusion **39**
Bibliography **40**
Appendix: Alternative Specifications **44**
A.1 Probit model 44
A.2 First stage regression 45
A.3 Event study and placebo test 46
A.4 Unemployment rate 48
A.5 Changes in wind capacity 49

1. Introduction

The European Union has the goal of becoming carbon neutral by 2050 (European Commission, 2026), which entails that there is a need to reshape the energy systems and local economies across the old continent and the entire globe through the implementation of renewable energies (IEA, 2025; IRENA, 2025). Among them, wind power has been expanding for the past 20 years (IEA, 2025; IRENA, 2025), mainly driven by climate policies, technological advancements, and cost reduction. In this scenario, Sweden represents a particularly relevant case; in fact, wind energy has become an increasingly important component of the Swedish electricity mix, and installations are heavily concentrated in sparsely populated municipalities. Moreover, while the expansion is central for achieving decarbonization goals, studies have found that it also generates localized economic effects since wind farms are geographically bounded investments that interact directly with local communities (Brown et al., 2012; Ejdemo and Söderholm, 2015; Slattery et al., 2011; Okkonen and Lehtonen, 2016). Such investments can influence, among other things, local labor markets, land values, municipal finances, and income distribution according to Krugman (1991) and Fujita et al. (2001). Meaning that understanding how renewable energy development affects local economic outcomes is an important question not just for economists but also for policymakers, and it is ever so relevant.

Wind power projects can generate multiple local economic benefits. For example, during the construction phase of a project, there is an increased demand for labor, materials, and services. These effects are clearly only temporary. However, Slattery et al. (2011) found that a project also creates long-term benefits through the operation and maintenance activities (O&M), though they are more modest in size. Moreover, wind farms can produce income streams through land lease payments to property owners and through fiscal revenues from electricity production. At the same time, Sun et al. (2026), Topcu and Tugcu (2020), Slattery et al. (2011), and Okkonen and Lehtonen (2016) found that these benefits are unlikely to be distributed evenly within local communities. Lease payments typically accrue to a limited number of landowners, employment opportunities may favor specific skill groups, and fiscal revenues depend on national redistribution systems (Statistics of Sweden, 2026). As a result, wind power expansion may alter the distribution of income within municipalities even in cases where average income increases.

These distributional effects are of particular relevance in Sweden, since wind power deployment has increased exponentially from the early 2000s, especially after the introduction of the electricity certificate system in 2003 (Swedish Energy Agency, 2025). This measure made wind energy a major component of Sweden's electricity mix, which in 2024 was at 25.1 percent (Eurostat, 2026). Meanwhile, installations are not built uniformly across the country; the majority are located, in fact, in

sparsely populated and peripheral municipalities. Based on the municipal dataset used in this study[1], in municipalities that have a wind farm, the average population density is around 72 inhabitants per square kilometer; in municipalities that do not have a wind farm, the average population density is around 330, compared to the national average of 165. This spatial unevenness helps raise questions about how important the economic benefits and costs of renewable energy expansion are distributed between and within municipalities.

In Sweden's case, there is also another factor that needs to be taken into consideration when discussing the outcomes of wind power developments: the municipal veto right. In fact, all municipalities have the right to stop every renewable energy development project at any stage, even when approved by the central government (Lindvall, 2022). This makes the decision-making structure decentralized and gives a lot of power to the local political structures, as well as a higher dependence on the socioeconomic conditions of each municipality, as per Larsson et al. (2014). Consequently, wind power expansion in Sweden is not only a technological or environmental phenomenon but also a local economic and political process.

While research on the local impacts of renewable energy has increased, the literature still contains notable gaps. Much of the international evidence concentrates on employment structure effects or aggregate economic outcomes, often studied using input–output models or panel data methods (Slattery et al., 2011; Okkonen and Lehtonen, 2016; Brown et al., 2012). These studies offer great insights into potential economic benefits, but they do not investigate distributional outcomes within local communities or across them. If you restrict the scope to the Swedish context alone, the research field is concentrated on the projected regional development effects, labor market impacts, and the characteristics of residents living near the turbines (Arnborg, 2021; Lundin and von Platten, 2024). However, relatively little work has systematically analyzed how wind power expansion affects income inequality and local economic structure at the municipal level (e.g. Topcu and Tugcu, 2020; Westlund and Wilhelmsson, 2025; Niskanen et al., 2024; Lundin, 2024; Ejdemo and Söderholm, 2015).

This thesis contributes to the literature by providing one of the first nationwide, quantitative assessments of the regional development effects of wind power infrastructure in an advanced economy. By examining the effects on municipal income, income inequality, labor market structure, and heterogeneous local effects, the study extends existing work on energy infrastructure and regional inequality. The results are expected to inform policy debates on the spatial equity of the green transition and the design of local benefit-sharing and compensation mechanisms in Sweden.

The analysis aims to explore three different objectives:

[1] My calculations based on municipal population density and wind farm location data described in the data section, Section 6

1. The first objective examines whether wind power expansion creates income disparities across municipalities. This is divided into two steps. First, it identifies if measurable income gains exist at the municipal level. Second, it examines the distributional effects across municipalities, testing the premise that wind power affects income differently depending on population density, political views, income, geography, and the timing of adoption. In other words, the impact is likely to be heterogeneous; while more urbanized municipalities may see broad income diffusion through labor markets, more peripheral municipalities may see benefits concentrated among a few, leading to an uneven distribution of economic gains between different municipalities (e.g., Bartik, 1991; Blanchard and Katz, 1992; Moretti, 2010; Fujita et al., 2001; Ejdemo and Söderholm, 2015).
2. The second objective examines whether wind power expansion affects income inequality within municipalities. It tests whether increases in wind power production correlate with changes in the local GINI coefficient. While wind-related investments generate new income streams, the extent to which these are distributed evenly among a municipality's residents remains an empirical question. Thus, the analysis seeks to determine if wind expansion drives internal income dispersion (e.g., Topcu and Tugcu, 2020).
3. The third objective is to examine whether wind power expansion is associated with shifts in local employment structure, particularly toward industrial and service-related employment (e.g. McMillan et al., 2014; Brown et al., 2012;).

From these objectives, three corresponding hypotheses are derived:

1. The income effects of wind power expansion are unevenly distributed across municipalities, varying according to local characteristics such as population density, political views, income, geographical position, and timing of adoption.
2. Wind power expansion increases income inequality within municipalities.
3. Wind power expansion increases the share of employment in the industrial and service sectors within municipalities.

The remainder of this study is organised as follows. Section 2 presents the background, and Section 3 provides a literature review. Section 4 describes the theoretical background. The empirical strategy and the data utilized in the analysis are, respectively, in Sections 5 and 6. Section 7 provides the results, while Section 8 presents the discussion and policy implications, followed by Section 9, which presents the conclusion.

2. Background: Wind Power Expansion and Municipal Economic Exposure in Sweden

2.1 The expansion of Wind Power in Sweden

Over the past two decades, wind power has become a central component of Sweden's renewable energy transition. As presented in Figure 1, it can be noted that a clear upward trend can be observed, where the share of wind power production has been increasing for the past two decades. The installed capacity, in fact, jumped from 0.3 percent of electricity production in the year 2000 to 25.1 percent in 2024 (Eurostat, 2026). This is mainly due to the introduction of the Electricity Certificate System, which was introduced in 2003 to boost the production of renewable electricity in a cost-efficient way (Swedish Energy Agency, 2025).

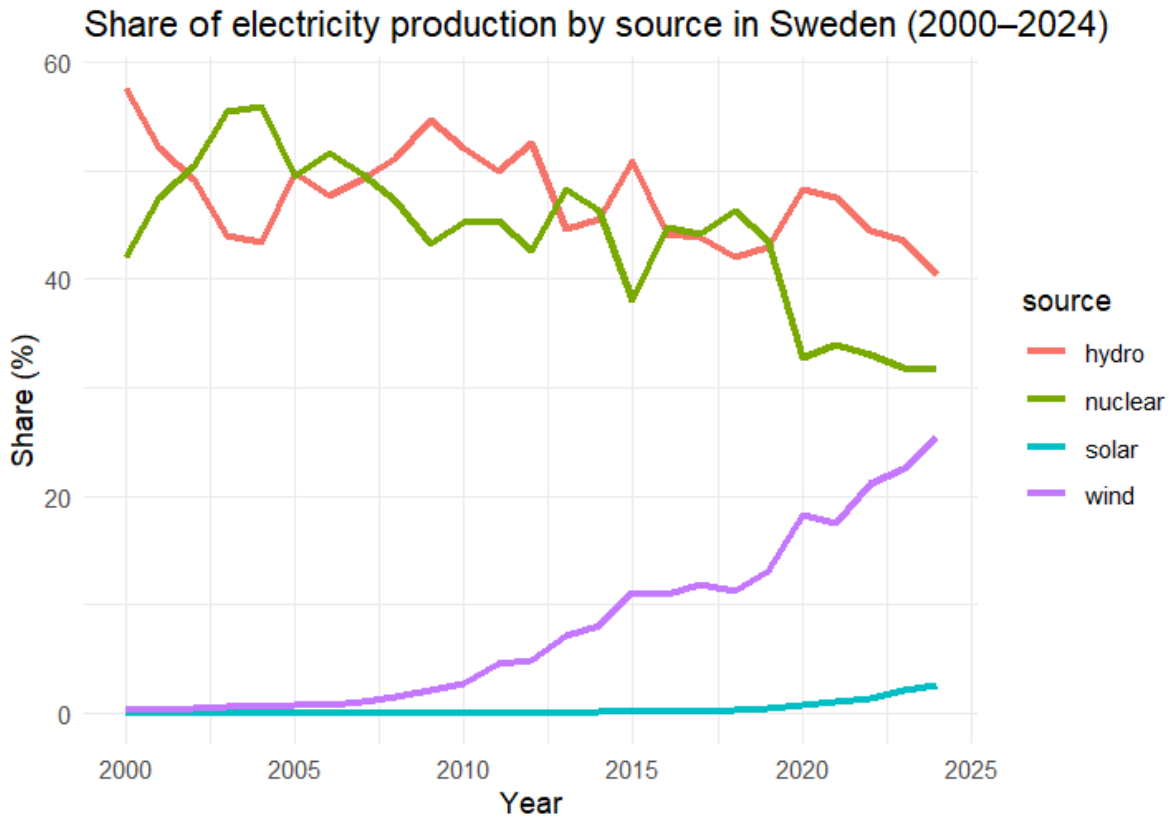


Figure 1: Share of electricity production by source in Sweden from 2000 to 2024
NOTE: The figure shows how the share of electricity production, based on the type of source, developed from the year 2000 to 2024

Because of a different array of characteristics from wind conditions, land availability, grid capacity, and political acceptance, it can be seen from the two maps below (Figure 2) that the wind power

deployment is geographically uneven. In the Swedish case, the majority of the wind production is located in peripheral municipalities and in the northern part of the country.

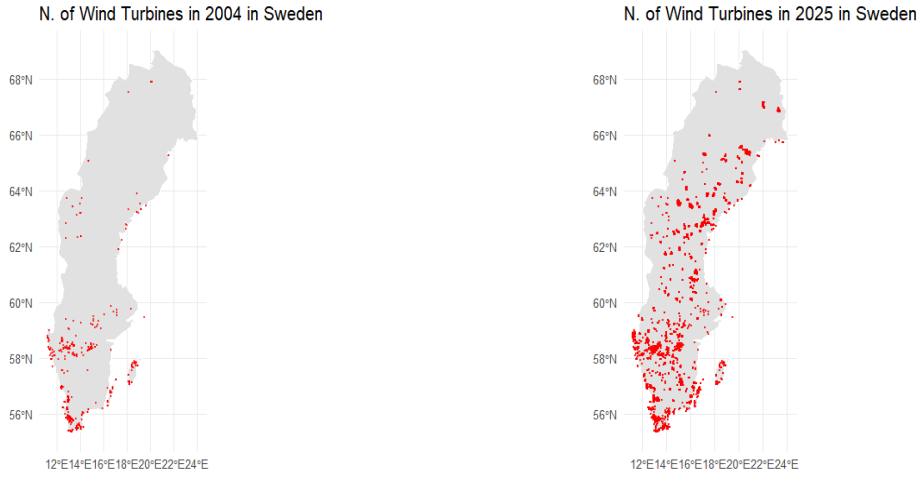


Figure 2: Number of wind turbines in Sweden in 2004 and in 2025
NOTE: The image on the left shows the amount of wind turbines that were present on swedish soil in the year 2004 while the image on the right shows the amount of wind turbines that were present on swedish soil in 2025

Furthermore, Figure 3 shows that roughly 60 percent of the electricity from wind farms is, in fact, produced in northern Sweden, Elområden 1 and Elområden 2 (Swedish Energy Agency, 2023).

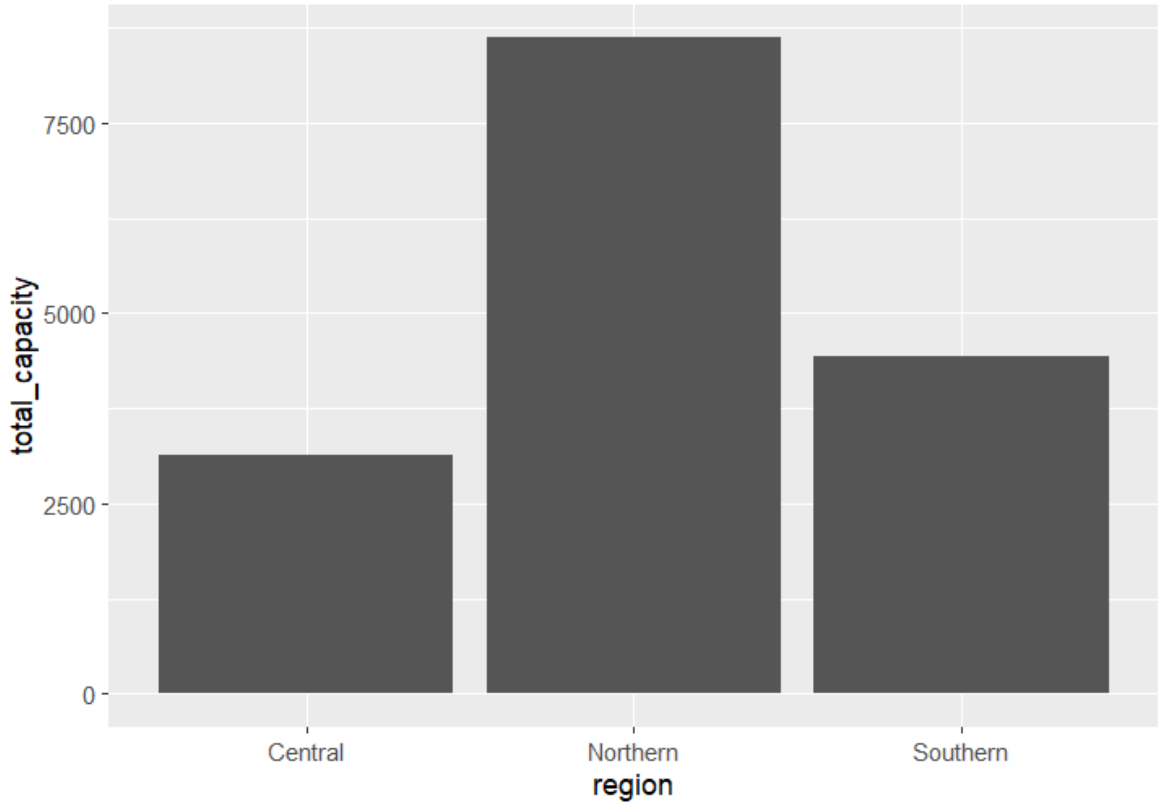


Figure 3: Wind Power Capacity across Swedish Regions
NOTE: The figure shows wind power capacity across three geographical regions of Sweden: southern, central, and northern Sweden. Southern Sweden includes Skåne, Halland, Blekinge, Kronoberg, Kalmar, Gotland, Jönköping, and Västra Götaland counties. Central Sweden includes Stockholm, Uppsala, Södermanland, Östergötland, Västmanland, Örebro, Värmland, Gävleborg, and Dalarna counties. Northern Sweden includes Västernorrland, Jämtland, Västerbotten, and Norrbotten counties.

This uneven spatial distribution means that municipalities differ substantially in their exposure to wind power investments. While some municipalities host large-scale wind installations and are directly affected by associated economic activity, others experience little or no direct impact. As a result, the economic and fiscal effects of wind power, such as employment creation, land lease income, and changes in the local tax base, are unevenly distributed across space. This uneven exposure is central to the empirical analysis of this thesis. It generates variation across municipalities in the intensity of wind power development, which can be used to examine how renewable energy expansion affects local income inequality and employment structure.

2.2 The Municipal Governance Framework and the Veto Power

In Sweden, there is a decentralized planning system that gives municipalities substantial influence over wind power development. Municipalities hold extensive authority over land-use planning through what is commonly referred to as the municipal veto. Under the Environmental Code and the municipal planning monopoly established in the Planning and Building Act municipalities have the primary responsibility for planning land and water use (Plan- och bygglag (2010:900). This implies that municipal approval is required on top of the nationally approved permits (Lindvall, 2022),

meaning that municipalities have the authority to block projects even when they align with the national objectives of renewable energy.

This institutional framework creates a multi-level governance structure where municipal decision-making plays a central role, according to Larsson et al. (2014). Previous research, such as Söderholm et al. (2007), has also shown that national renewable energy policies are frequently met with local resistance as well as planning obstacles, which reinforce how important the municipal-level approval is in shaping outcomes. Resulting in wind power reflecting not only geographic suitability, such as wind conditions and land availability, but also local political preferences and socioeconomic considerations. The municipal veto thus introduces a political-economic dimension to the spatial allocation of wind power investments, making wind power expansion not only an energy policy issue but also a local political and fiscal matter.

2.3 How Municipalities Gain (or Do Not Gain)

Wind turbines are subject to property taxation. In Sweden, property tax on electricity-producing units is levied at the national level; wind farms are, in fact, subject to the national property tax ("statlig fastighetsskatt" in Swedish) (Skatteverket, 2026). As a consequence, the revenues enter the central government budget before being redistributed to municipalities through the intergovernmental fiscal equalization system (Statistics of Sweden, 2026). Although the exact local fiscal effect depends on the design of the equalization scheme, wind installations expand the local tax base and may generate fiscal benefits for host municipalities. However, due to the structure of the equalization system, these fiscal gains are generally limited and unlikely to represent a substantial source of municipal revenue.

Nonetheless, because the equalization system redistributes revenues across municipalities, gains are partially pooled at the national level (Statistics of Sweden, 2026). Municipalities hosting wind farms, therefore, do not necessarily retain the full marginal increase in tax capacity. As a result, fiscal gains may be positive but attenuated, and their magnitude varies depending on the municipality's pre-existing tax base and position within the equalization system. This limited fiscal retention has been highlighted in recent research as a factor shaping municipal incentives in wind power development (Niskanen et al., 2024; Lundin, 2024).

Wind farms are typically built on privately owned land. Developers pay lease payments to landowners, which generate capital income streams that can persist over the entire lifetime of the installation, according to Henningsson et al. (2013). These payments often present a fixed base and, in some cases, a production-varying component linked to electricity output. In rural municipalities, lease revenues may be substantial relative to average income levels and can therefore represent a meaningful local economic transfer. But land ownership is frequently concentrated, particularly in

rural regions, according to Thorstensson and Karlsson (2015). This implies that rather than being widely dispersed throughout the population, lease income is accumulated by a small number of property owners. In municipalities with unequal land ownership structures, wind power expansion may therefore increase income dispersion even if average income rises.

Additionally, estimates on the order of several job-years per installed megawatt of wind power suggest that projects create employment and economic activity, especially during the construction phase (Slattery et al., 2011; Okkonen and Lehtonen, 2016; Ejdemo and Söderholm, 2015; Arnborg, 2021). During this phase, an increase in short-term employment for local workers and service providers can be observed. In turn, this can lead to higher local income and indirect tax revenue, even if the effects won't be captured directly as wind-specific tax revenue. The operational and maintenance phase has been found to create long-term jobs, though typically smaller in number since wind energy is capital-intensive, with studies commonly finding around 0.1–0.3 permanent jobs per megawatt installed (Slattery et al., 2011; Okkonen and Lehtonen, 2016; Arnborg, 2021).

While these employment effects are not fiscal transfers to municipalities per se, they can still raise household incomes and increase taxable economic activity, thereby generating indirect local fiscal benefits. The mechanisms discussed above are often linked to questions of public acceptance of wind power. However, beyond acceptance, they also have implications for how the economic effects of wind power are distributed within municipalities. In particular, the concentration of land ownership, the structure of fiscal redistribution, and the nature of employment effects suggest that the local benefits of wind power may not be evenly shared across households.

2.4 Why Wind Power May Affect Inequality

Although wind power can generate aggregate economic gains, Ejdemo and Söderholm (2015) found that these gains do not appear to be evenly distributed.

Several mechanisms may generate within-municipality inequality:

- Lease payments benefit landowners disproportionately (Ejdemo and Söderholm, 2015)
- Construction jobs may favor specific skill groups (Ejdemo and Söderholm, 2015)
- Capital-intensive production limits broad labor income effects (Moretti, 2010)
- Fiscal gains depend on redistribution rules (Niskanen et al., 2024; Lundin, 2024)
- Property value effects may differ across households (Westlund and Wilhelmsson, 2025)

Capital income streams may exacerbate income inequality in small rural municipalities since they are characterized by limited labor market diversification and concentrated land ownership, according to Ejdemo and Söderholm (2015). On the opposite end, Moretti (2010) states how employment effects

may be more broadly distributed in larger or more diverse municipalities, which could potentially mitigate inequality.

In conclusion, more wind power does not always lead to more equal growth. In fact, whether an increase, a decrease, or no change can be observed is an empirical question that depends on things like the local economy, ownership patterns, and the institutional context; however, these mechanisms cannot be separately identified in the empirical analysis. The results, therefore, capture the combined effect of wind power expansion rather than distinguishing between the different channels through which it may operate.

3. Previous Literature

This thesis relates to three main strands of literature: (3.1, 3.2) the local economic impacts of wind power development, (3.3) the Swedish institutional and policy context of wind power deployment, and (3.4) distributional and social consequences. The first one evaluates whether wind power investments generate measurable economic benefits at the local level. The second one examines how planning systems, governance structures, and compensation mechanisms shape both the location and the outcomes of wind power projects, while the third one examines how economic activity and local development outcomes are unevenly distributed.

3.1 Local Economic Impacts of Wind Power Development in the World

With the utilization of renewable energy sources ever increasing, the phenomenon is becoming more and more relevant from an economic perspective to test its effects on a variety of different factors, one of them being local effects. For this reason, the empirical literature on the effects of wind power investments on local communities is increasing. There are several studies analyzing and showing that wind energy projects can bring positive impacts through the construction and O&M phases (Slattery et al., 2011; Sun et al., 2026; Topcu and Tugcu, 2020; Xia and Song, 2017; Okkonen and Lehtonen, 2016).

Slattery et al. (2011), for example, presented the impacts of a variety of wind power installations on four different counties in Texas, USA. The paper utilized the Jobs and Economic Development Impacts (JEDI) Wind model; this model, as Slattery et al. (2011) explained, is an input-output tool that uses standard multipliers and consumption patterns. The aforementioned impacts are the amount of employment that the construction phase has brought, the equivalent of 4,100 jobs, the total lifetime economic activity to both the state, $1.8 billion, and the local communities, $730 million. These are stronger in the short-term period, while in the long-term, in the O&M phase, they get more modest.

This study highlighted the importance of distinguishing between phases of project life, construction versus O&M, in assessing economic benefits, and underscores the usefulness and limitations of multiplier-based simulation models for capturing local impacts.

In Sun et al. (2026), the authors analyzed the effects of renewable energy investments on income distribution in China, and employed the Partially closed input-output and the Miyazawa models. The latter one is a revisited Partially closed input-output model, where for each resident's income group, a multi-group income distribution model is built, allowing for the analysis of different impacts of renewable energy investment on the different groups. They found that the impact of renewable energy investment on income steadily declined across all income groups. When the sample is divided into subgroups, the results reveal an unequal distribution of benefits, with stronger income growth appearing in more economically developed regions than in less developed ones, and low-income groups benefit less from these investments compared to middle and high income groups.

While Slattery et al. (2011) were focused on the accrued economic results from the installation of wind farms, Topcu and Tugcu (2020) shifted the analytical lens to the distributional outcomes associated with renewable energy more broadly in advanced economies. Their study investigated whether higher renewable energy consumption, not just wind, affects income inequality across a panel of 23 developed countries over 1990–2014. This study employed two different methods to answer the question: the first one is a panel of generalized methods of moments, while the second one is the dynamic common correlated effects estimator. The generalized method of moments, according to Hansen (1982), is able to address unobserved heterogeneity, omitted variable bias, measurement error, and potential endogeneity. The Dynamic Common Correlated Effect Estimator is designed to estimate models with dynamic components and unobserved common factors. Topcu and Tugcu (2020) reached the conclusion that an increase in renewable energy usage is correlated with a negative and statistically significant income inequality.

Another contribution to the literature from a non-European context is Xia and Song (2017), who explored the effects that wind power can inject into local economies in China, while emphasizing the importance of who gets the benefits and who bears the costs. They take a look at how the county-level GDP and the fiscal income change as a consequence of wind power installations. The former is small and positive, while the latter is also small but interestingly a negative one. Xia and Song (2017) used an IV regression for the estimate, and the results are important because they present similar outcomes, when it comes to the GDP, compared to the same method applied to the United States of America in Brown et al. (2012), while the negative effect on the fiscal income is opposite. The authors suggested that it is due to the fact that China introduced a VAT exemption for wind installation, and since VAT income is one of the two most important sources of revenues for the municipalities, it was badly

affected. The other reason is that big corporations are usually not locally registered, hence the municipality does not gain any revenue from them. This country-induced difference shows how local characteristics, as well as the country policy framework, are relevant when analysing the effects of an installation. These can shape local economic outcomes in ways that differ sharply from what simple input-output effects would suggest. The two papers mentioned just above, Xia and Song (2017) and Brown et al. (2012), have been chosen as the primary foundation for the empirical analysis in this thesis since they examined the most comparable case studies and methodological approaches to those considered in this thesis.

Turning to Europe, Okkonen and Lehtonen (2016) assessed the socio-economic impacts of eleven community wind farms in northern Scotland using an input-output method similar to JEDI, mentioned before in Slattery et al. (2011). Their results point to positive impacts on local income and employment during both construction and O&M phases, with significantly stronger effects during construction. Importantly, they also consider the effects of reinvesting wind-generated income within the local economy, finding that such reinvestment can amplify employment impacts up to eight times compared to traditional production linkages. This finding highlights how local participation and retention of economic benefits can significantly influence the magnitude of positive effects.

Altogether, the international-context studies show that wind power investments can generate local economic benefits; although the size and distribution of these gains depend on contextual factors, policy environments, and methodological approaches. Multiplier-based simulation models, such as the JEDI model, provide useful estimates of potential impacts, but they may overlook important contextual elements, including fiscal regimes, ownership arrangements, and distributional outcomes. Moreover, empirical approaches that use causal identification strategies, for example, IV regressions and dynamic panel estimators, reveal broader socioeconomic consequences that extend beyond simple employment multipliers.

3.2 Local Economic Impacts of Wind Power Development in Sweden

While the previous paragraph presented research papers that focused on various countries, the following one will only focus on the Swedish national perspective, which is more limited and mixed in terms of methods and findings. The existing studies tend to focus either on projected impacts from proposed projects or on specific labor market outcomes, rather than offering broad empirical evaluations to test generalizable effects across municipalities.

One of the earliest Swedish-focused contributions is Ejdemo and Söderholm (2015), which aimed to find out how wind power can promote regional development and employment. They also wanted to investigate which benefit-sharing instruments can enhance the positive effects. The paper had a

restrictive scope, since it only analyzes the county of Norrbotten in northern Sweden. They used a specific input-output model called the Swedish regional impact model rAps that combines economic and demographic models, and that was developed by the Swedish Agency for Economic and Regional Growth in 2000 (Cedefop, 2026). With the Arps, they could estimate the potential regional economic impacts of a proposed inshore wind farm, since the county in question does not have any installations as of right now, but a 4 GW wind power project is being developed. The results that they proposed show that the construction phase, in particular, had a positive effect on the local economy, especially if local manufacturing exists. More interestingly, they also stated how, with a lack of profit-sharing mechanisms, the employment effect is positive but modest in size.

On a similar topic but expanded to the entirety of Sweden, Arnborg (2021) studied the local economic impacts of wind power deployment. Another difference is presented in the method chosen, a difference-in-differences (DiD) model to quantify how municipal-level unemployment rates are affected by wind power investments. This quasi-experimental method compares changes in unemployment over time between municipalities that invest in wind power and those that do not, thereby controlling for common time trends and fixed differences between areas. Arnborg (2021) found that an average wind power project can lead to a decrease of 0.33-1.2 percent in unemployment. The interesting insight is that the effect is shown to be stronger in the O&M phase rather than in the construction phase, which is the opposite of what the previous literature presented.

In summary, the Swedish literature provides evidence of positive but modest local economic impacts, with differences in labor market and socioeconomic outcomes that sometimes diverge from international patterns. These studies also hint at deeper institutional and distributional forces shaping outcomes, motivating the need to integrate economic and institutional analyses.

3.3 Swedish institutional and policy context

A distinct but related strand of the literature looks at how institutional arrangements, governance structures, and policy design affect the location, acceptance, and performance of wind power deployment. In the Swedish context in particular, it is difficult to separate economic outcomes from the institutional environment in which projects are approved (e.g., Lindvall, 2022; Söderholm and Pettersson, 2011; Thellbro et al., 2023; Liljenfeldt and Pettersson, 2017; Lundin and Von Platten, 2024).

A central theme in Swedish literature is the role of municipalities in planning and permitting processes. Sweden’s decentralized planning system gives local authorities significant discretion in approving or rejecting wind power projects, which has important implications for deployment patterns. Lindvall (2022) presented what is the current acceptance situation of wind power in Sweden

at the municipal level and the effectiveness of different kinds of compensation schemes. Concluding that acceptance is not merely a function of economic incentives alone, especially in higher-income areas, since the opposition may instead be driven by factors that go beyond economic concerns, such as visual or environmental impacts.

Policy design also plays a role. Söderholm and Pettersson (2011) argued that while existing support schemes have facilitated wind power development, they may not be strong enough to encourage more large-scale investment. At the same time, Thellbro et al. (2023) presented evidence suggesting that although many municipalities express interest in wind power expansion, relatively few projects are ultimately realized in practice.

More recent work points to the importance of local socioeconomic characteristics. Lundin and Von Platten (2024), for example, found that residents near wind turbines have persistently lower earnings (about 14 percent lower) and roughly one year less education than the average Swedish resident. Similarly, Liljenfeldt and Pettersson (2017) showed that areas rejecting wind projects tend to have younger, more educated, and higher-wage populations with higher property values. In line with this, Westlund and Wilhelmsson (2025) presented that property values tend to be lower in areas surrounding wind farms, with declines persisting after turbine construction.

To summarize, these findings point out that both institutional factors and local characteristics play a role in determining where projects are located. Which, in turn, means that wind power projects may not be randomly distributed across municipalities. This is important for the empirical analysis, as it points to potential selection effects, which are explicitly addressed in this thesis.

3.4 Distributional and Social Consequences

There is also a smaller body of literature that highlights the social and distributional consequences of wind power deployment. This is focused on contexts that involve indigenous or marginalized communities, mainly in developing nations. Papers such as da Conceição et al. (2024) and Jung (2017) showed that wind power impacts are not limited to the economic or institutional aspects but also social and cultural ones, which are shaped by community perceptions, histories of marginalization, and local power relations. Even though most evidence on these dimensions comes from non-European contexts, which makes it less applicable to the Swedish setting, it still underscores the need to examine similar distributional questions within Sweden, particularly as debates over acceptance and equity intensify.

3.5 Synthesis and Gaps in the Literature

As discussed in the previous sections, the literature offers significant insights into the institutional, social, and economic dynamics of wind power development across these strands. Although there is evidence from around the world that wind investments can have a positive economic impact locally, the extent and distribution of these effects vary depending on the methodology, policy design, and context. Input-output models, for example, tend to measure stronger local impacts compared to causal econometric models

Even though there are still significant gaps, the empirical research in the Swedish context has made significant strides in documenting institutional influences and estimating local economic impacts. Instead of combining institutional factors with more general economic outcomes in a cohesive empirical framework, many Swedish studies concentrate on anticipated effects or particular outcomes, such as unemployment or socioeconomic disparities close to turbines. Additionally, while equity and justice concerns are emphasized in international distributional studies, Swedish studies have not yet fully integrated these dimensions into empirical analyses of local wind power impacts.

3.6 Conclusion of the Literature

While there is plenty of academic evidence supporting both the economic and institutional dimensions of wind power development, several gaps, however, remain unfulfilled. On the International front, the studies rely most heavily on multiplier-based simulations or on aggregate econometric approaches, which do not leave much room for the integration of institutional characteristics into the empirical outcome analysis. In the Swedish context, the literature has largely focused on projected impacts, specific labor market outcomes, or distributional concerns, but they rarely combine them with a unified framework. Moreover, not much attention has been paid to how the local institutional conditions interact with measurable economic outcomes at the municipal level, since the literature is mainly focused on the important role that they have.

4. Theoretical Framework

This thesis conceptualizes wind power expansion as a localized, capital-intensive infrastructure shock that alters municipal income composition and labor demand. Because wind farms are geographically immobile and dependent on site-specific wind potential, their economic effects are inherently place-based and spatially uneven. Drawing on Economic Geography models (Krugman, 1991; Fujita et al., 2001), wind power expansion may influence regional outcomes differently depending on population density, economic activity, and connectivity. In economic geography, the focus is on how production is distributed across space. A central and most notable feature is agglomeration, the

tendency for economic activity to cluster geographically, which reflects the presence of some form of increasing returns to scale (Krugman, 1991). That is because wind power expansion represents a spatially concentrated and place-based economic intervention. This theoretical framework can therefore help explain both the potential development gains and the distributional consequences associated with renewable energy expansion.

4.1 Wind Power as a Place-Based Economic Shock

Economic shocks in regional economics are typically defined as exogenous changes in local economic conditions that affect labor demand, income, or production (Moretti, 2010). These shocks can be either temporary or persistent, depending on whether they affect short-run demand or long-run productive capacity. In the literature, there is a clear distinction between short-term and labor-intensive shocks, also called construction-type demand shocks, and long-term capital-intensive shocks, which are called operational shocks. These shocks transmit via local labor markets through direct employment effects, input-output linkages, fiscal and income channels, and local consumption multipliers according to Moretti (2010) and Slattery et al. (2011).

The construction of a wind farm, as well as its expansion, can be interpreted as a local economic shock that affects municipalities through several channels, with two distinct phases. The first one is the construction phase, in which the project creates a demand for mainly manual labor, but also material and services, leading to a short-term increase in local employment and income. The second phase is called operation and maintenance (O&M), and here, according to Slattery et al. (2011), the wind farm generates a demand for maintenance, monitoring, and administrative services, which, given the nature of the phase, will have a longer-lasting effect. In addition to these two straightforward economic effects, wind farms can generate income flows through land lease payments and local tax revenues. As a result, wind power expansion has the potential to influence not only aggregate economic outcomes but also the within-municipality distributional patterns. That is the reason why I have decided to analyze beyond income effects and to consider income inequality and employment structure.

The theoretical mechanisms discussed above can be summarized as follows. Wind power expansion constitutes a local economic shock that affects municipalities through three main channels: (i) direct labor demand during construction and operation phases, (ii) capital income through land rents and fiscal revenues, and (iii) local multiplier effects through increased demand for goods and services. These channels jointly determine changes in income levels, income distribution, and sectoral employment composition.

4.2 Agglomeration and Heterogeneous Local Effects

Economic geography models (Fujita et al., 2001; Krugman, 1991) tell us how important factors such as market size, transport costs, and agglomeration economies are in shaping the regional development growth patterns. Fujita et al. (2001) also mentioned that economic activity is unevenly distributed across space due to agglomeration economies. The aforementioned models highlight three main mechanisms: the first one being an increase in returns to scale in production, the second one being the fact that larger markets attract more activity, and the last one being the presence of spillover effects, meaning that productivity increases with density. A central implication, according to Fujita et al. (2001), is that identical shocks can generate heterogeneous outcomes across regions, depending on pre-existing density, industrial structure, and connectivity. More developed regions tend to amplify shocks through stronger multiplier and spillover effects.

In the context of wind power expansion, these mechanisms imply that municipalities with higher economic density and stronger industrial bases may be better able to capture local spillovers from wind-related investments. If, for example, in the construction phase, local construction companies are employed, rather than outside ones, the wind power expansion may contribute to broader developments that go beyond the direct gain produced by wind power itself. In contrast, peripheral municipalities may experience more limited spillovers if inputs and labor are imported from outside the local economy.

This framework leads to the following testable implication: municipalities with higher population density and stronger pre-existing economic structures are expected to experience larger income gains from wind power expansion due to stronger local multiplier effects and spillovers.

4.3 Distributional Effects and Local Inequality

Local labor market theory predicts that positive labor demand shocks affect both wages and population through supply adjustments and migration responses (Moretti, 2010). When labor supply is imperfectly elastic, wage increases are concentrated among workers in sectors directly affected by the shock. In addition, income shocks may affect inequality depending on:

- Factor ownership structure (labor vs capital income)
- Skill heterogeneity of employment effects
- Labor market segmentation

When shocks generate capital income (e.g., rents or dividends), distributional effects depend on how narrowly ownership is concentrated. Local multiplier effects further suggest that increases in income

may generate secondary employment and consumption effects, but the magnitude depends on local labor supply elasticity (Moretti, 2010).

Wind power expansion generates both labor income (construction and O&M employment) and capital income (land lease payments and tax revenues). The distributional impact, therefore, depends on the local ownership structure of land and the skill composition of employment. In municipalities where land ownership is concentrated, capital income from wind installations may increase income dispersion even if total income rises. In contrast, where employment effects are broadly distributed across households, inequality effects may be weaker.

This framework yields ambiguous theoretical predictions regarding inequality. On the one hand, broadly distributed employment gains may reduce inequality. On the other hand, if income gains primarily accrue through capital income, such as land rents, and ownership is concentrated, wind power expansion may increase income inequality. Therefore, the overall effect is an empirical question. However, it is important to note that this analysis does not examine these mechanisms directly.

4.4 Structural Change and Employment Composition

Structural transformation theory provides a framework for understanding how economies change over time through shifts in employment across sectors, typically moving from agriculture to industry and services, as mentioned by McMillan et al. (2014). Investments in infrastructure can contribute to this process by increasing demand in specific sectors and thereby influencing the composition of local employment. However, when investments are capital-intensive, their effects on employment tend to be more limited and concentrated in particular types of occupations, rather than generating broad-based structural change across the economy.

When it comes to wind power, in the construction phase, local employment is expected to temporarily vary towards industrial and construction-related sectors. In the longer run, activities such as operation and maintenance may lead to an increase in demand for technical and service-oriented occupations. However, because wind energy is capital-intensive, long-run structural change effects are likely to be moderate rather than transformative.

Regional development theory, agglomeration models, rent-based income theory, and structural transformation frameworks taken together suggest that wind power expansion constitutes a spatially uneven economic shock. It also shows that aggregate and distributional effects are likely to vary across municipalities based on their pre-existing economic structure and demographic composition. The theoretical prediction is that wind power expansion will primarily increase employment in

construction and technical service sectors, with limited long-run effects on broader structural transformation due to its capital-intensive nature.

5. Empirical Strategy

The empirical analysis proceeds in three different parts, based on the three different hypotheses presented in the Introduction. First, the study estimates the effect of wind power expansion on municipal economic outcomes using fixed effects regressions that control for both municipality-specific and year-specific characteristics. Then it proceeds by checking whether the distributional effects are different between certain types of municipalities. The same specification has been run with interaction terms based on different characteristics: population density, income levels, the geographical collocation of the municipality, as well as the time of the first wind power installation. In the second part, the effects of wind power development on the inter-municipal inequality have been examined by utilizing the GINI coefficient as the dependent variable. Third, the analysis investigates if an expansion in wind power development is associated with changes in local labor market structure, focusing on sectoral employment shares.

The baseline empirical specification is given by equation 1:

$$Y_{it} = \beta \log\left(\frac{\text{WindCapacity}_{it}}{\text{Population}_{it}/1000}\right) + X_{it}'\theta + \gamma_i + \delta_t + \epsilon_{it} \quad (1)$$

where Y_{it} corresponds to the outcome of interest in municipality i and year t, it includes measures of the logarithm of income per capita, income inequality measured as the GINI coefficient, and sectoral employment share. The main explanatory variable is defined as the logarithm of installed wind power capacity per 1000 inhabitants. This normalization is done in order to account for differences in municipality size and captures the intensity of wind power exposure relative to the local population. X_{it} is a vector of the municipal characteristics that vary with time, γ_{i} represents the municipality fixed effects, while δ_{t} represents the year fixed effects. β, the coefficient of interest, measures the effect of wind power expansion on the local outcomes. This specification exploits within-municipality variation over time while controlling for time-invariant unobserved heterogeneity and aggregate shocks.

The key identification challenge is the endogenous placement of wind power installations. Municipalities with favorable wind conditions, land availability, or economic characteristics are more likely to attract wind investments, and these same factors may also directly affect local economic outcomes, leading to biased ordinary least squares estimates. To address this concern, the analysis employs a leave-one-out shift-share (Bartik) instrumental variable that uses differential municipal

exposure to national wind power expansion, following Gagarin (2022) and the standard shift-share framework (Goldsmith-Pinkham et al., 2020; Blanchard and Katz 1992; Bartik, 1991). The instrument is constructed as the interaction between time-invariant, spatially varying wind potential (the share), which is a measure of the yearly average wind speed, at the municipality level, and the time-varying but spatially common total annual wind capacity installed at the national level (the shift). This approach exploits differential exposure of municipalities to a common national expansion in wind power. The identifying variation arises because municipalities with higher wind potential experience larger increases in wind capacity when national investment expands, while the timing and magnitude of national wind expansion are driven by aggregate factors such as national energy policy, technological progress, and macroeconomic conditions. As a result, the instrument isolates variation in local wind development that is plausibly exogenous to municipality-specific economic shocks. More specifically, the analysis utilizes a "leave-one-out" Bartik instrument, which consists of removing municipality i's own capacity from the national aggregate, in order to remove the mechanical endogeneity given by the dependent variable regressor (the municipal wind capacity) being included in the instrument (total annual wind capacity installed). A valid instrumental variable, however, needs to satisfy two characteristics: relevance and exogeneity (Wooldridge, 2012). Plausibly, wind potential is correlated with wind power deployment, the former, but it does not directly affect income, income inequality, or sectoral employment share of a municipality except through wind power expansion, the latter. Under these assumptions, the instrumental variable approach allows for the identification of the causal effects of wind power expansion on municipal outcomes. A potential concern is that national wind expansion may correlate with broader economic trends; however, this is mitigated by the inclusion of year fixed effects and municipal controls.

5.1 Municipal Gains and Heterogeneous Effects of Wind Power (Hypothesis 1)

This section aims to examine if there are measurable economic gains at the municipal level as a consequence of wind power expansion. More specifically, it tests whether increases in wind power capacity are associated with higher income per capita. Wind power investments can create new income streams through land lease payments, local economic activity, and fiscal spillovers, potentially benefiting residents in host municipalities.

The empirical specification is shown below in equation 2:

$$\log(\text{Income}_{it}) = \beta \log(\text{CapacityPer1000}_{it}) + X_{it}'\theta + \gamma_i + \delta_t + \epsilon_{it} \quad (2)$$

where the dependent variable is the logarithm of annual average municipal income per capita and the main explanatory variable is the logarithm of installed wind power capacity per 1000 inhabitants,

which captures the intensity of wind power exposure relative to population size. Given that both the dependent and explanatory variables are logarithms, the β coefficient measures the percentage change in municipal income associated with a one percent increase in wind power capacity per 1000 inhabitants, as an elasticity. The vector X_{it} includes time-varying municipal controls such as population size, population density, education levels, and pre-existing income trends. Municipality fixed effects (γ_{i}) control for time-invariant characteristics, while year fixed effects (δ_{t}) account for common macroeconomic shocks.

As previously mentioned, to address endogeneity, an instrumental variable (IV) method has been applied, where wind potential multiplied by the leave-one-out measure of total national installed wind capacity (excluding municipality i's own contribution) is used as an instrument for installed wind capacity. The corresponding first-stage equation looks like equation 3 shown below:

$$\log(\text{CapacityPer1000}_{it}) = \pi\,\text{WindIV}_{it} + X_{it}'\lambda + \gamma_i + \delta_t + \nu_{it} \quad (3)$$

The same equation has been utilized with different interaction models to analyse whether there will be different distributional effects across different kinds of municipalities.

5.2 Municipal Income Inequality Effects of Wind Power (Hypothesis 2)

This section aims to examine whether intra-municipal income inequality is affected by wind power expansion. To be more precise, it examines whether an increase in wind power capacity is associated with a variation in the GINI coefficient, meaning changes in the income distribution at the municipal level.

The empirical specification is equation 4 shown below:

$$\text{Gini}_{it} = \beta \log(\text{CapacityPer1000}_{it}) + X_{it}'\theta + \gamma_i + \delta_t + \epsilon_{it} \quad (4)$$

In which Gini_{it} is the GINI coefficient in municipality i and year t, while the intra-municipal income inequality is the main explanatory variable. The vector X_{it} includes time-varying municipal characteristics, including population size, population density, education levels, political factors, and pre-existing income trends. Municipality and year fixed effects are included to control for time-invariant heterogeneity and common shocks. To address potential endogeneity in the placement of wind power installations, the estimation is carried out using the instrumental variable approach described above.

As a complementary specification, the analysis also considers changes in inequality over time by estimating the model in first differences, presented by equation 5:

$$\Delta \text{Gini}_{it} = \beta \log(\text{CapacityPer1000}_{it}) + X'_{it}\theta + \gamma_i + \delta_t + \epsilon_{it} \quad (5)^2$$

where ΔGini_{it} stands for the yearly change in the GINI coefficient. This specification focuses on short-run dynamics and provides a robustness check against persistent trends in inequality levels.

5.3 Local Labor Market Effects of Wind Power (Hypothesis 3)

This section aims to examine whether wind power expansion is associated with changes in the local employment structure, more precisely, whether an increase in wind power capacity leads to a reallocation of employment across the three sectors at the municipal level.

The empirical specification is as shown below in equation 6:

$$\text{SectorShare}_{ist} = \beta_1 \log(\text{CapacityPer1000}_{it}) + \beta_2 \left(\log(\text{CapacityPer1000}_{it}) \times \text{Sector}_s\right) + X'_{it}\theta + \gamma_i + \delta_t + \mu_s + \epsilon_{ist}$$

(6)

SectorShare_{ist} is the employment share of sector s in municipality i and year t, the main explanatory variable is the logarithm of installed wind power capacity per 1,000 inhabitants. In order to see whether the effects differ between the sectors, the explanatory variable is interacted with sector indicators, which define the three different sectors as either primary, secondary, or tertiary. Moreover, β_{1} explains the effect of wind power expansion on the baseline sector, the primary sector, while β_{2} measures the differential effect for the other sectors.

In line with the aforementioned specifications, the vector X_{it} includes time-varying municipal characteristics such as population size, population density, education levels, and political factors; municipality, year, and sector fixed effects (γ_{i}, δ_{t} and μ_{s}) are also included. In this specification, sectoral fixed effects are added as well to account for structural differences across sectors that may bias the estimated relationship between wind power expansion and local labor market outcomes. The endogeneity poses a threat in this specification as well, so the instrumental variable approach shown above is utilized here also. In this case, however, since an interaction is present, both wind potential and the interaction term are instrumented with the time-varying wind potential, ensuring a correct handling of endogeneity. Under the identifying assumption that wind potential

[2]I have decided to use the changes in the GINI coefficient but not the yearly changes in the wind power capacity because like it has been shown in Table A5 in the appendix, the basic model does not change.

affects sectoral employment only through its impact on wind power capacity, the estimated coefficients can be interpreted as causal effects. In particular, the interaction terms capture whether wind power expansion is associated with shifts in employment toward or away from specific sectors, thereby providing a direct test of Hypothesis 3.

6. Data

The empirical analysis uses a municipality–year panel dataset that covers all 290 Swedish municipalities. The dataset covers the period 2003–2024 for installed wind power capacity, and it is from the Swedish Energy Authority (Energimyndigheten). The municipal income inequality is measured using the GINI index, which is obtained from Statistics of Sweden (SCB) for the period 2011–2023; earlier data is not available. The employment outcomes, which include how the municipal population is divided between industrial and service sectors, come from Register-based labor market statistics (RAMs) of Statistics of Sweden (SCB) for the period 2004-2018. The analysis has also used official data from Statistics of Sweden for municipal population size, population density, and income per capita that cover the relevant timeframe. The unemployment data at the municipal level also comes from Statistics of Sweden; however, the time frame is reduced from 2008 to 2023. Urbanization levels are measured using the Global Human Settlement Layer (GHSL), which captures the share of built-up land for each municipality. The wind potential data come from the Global Wind Atlas produced by the Technical University of Denmark (DTU Wind Energy) in partnership with the World Bank Group. The education share variable measures the proportion of the adult population in each municipality that has attained at least a tertiary education. Political factors are captured through a municipal-level dummy variable constructed from election results over the period 1998–2022. This classification is intended to capture the role of the municipal veto, which may be influenced by political factors (Lindvall, 2022). To account for timing differences in wind power adoption, municipalities are classified as early or late adopters based on whether the first wind installation occurred before or after 2003. This specific year has been chosen as the cutoff value for two different reasons: since 92 of them already had or started implementing wind power in that year, it means that the sample is split almost exactly in half; the second reason is that in 2003, is when the electricity certificate system was introduced. Moreover, to account for neighbors' spillovers, a spatial weights matrix is constructed; more specifically, a first-order queen contiguity was employed to define neighboring municipalities. Under this criterion, two municipalities are considered neighbors if they share either a common boundary or a common vertex. The resulting spatial weights matrix was row-standardized, implying that the spatial lag represents the average value of neighboring municipalities. The entirety of the data utilized has been harmonized and merged using the official Statistics of Sweden identifiers, which ensured a consistent cross-sectional alignment. The variables,

such as the wind capacity per capita and the employment share by sector, have been constructed in order to facilitate the comparison of municipalities with different sizes and economic structures.

In order to make wind power capacity more comparable across municipalities of different sizes, it is expressed as wind capacity per 1000 inhabitants. In the empirical analysis, there are different outcome variables depending on the hypothesis. There are several characteristics included, such as the population size, population density, and average income, all of which are from official statistics. The second one utilizes the GINI coefficient as the main outcome variable, with values ranging from 0 to 1, with higher values indicating more income inequality. The outcome variable that is related to the third hypothesis is the share of the municipal workforce employed in the industrial and service sectors, based on register-based labor market statistics called RAMS. This allows for an examination of broader economic effects since these variables capture potential shifts in local economic activity associated with wind-related investments.

6.1 Data Structure and Type

The dataset has a municipality–year panel structure, allowing the exploitation of both cross-sectional and temporal variation. This structure makes it possible to identify within-municipality changes associated with wind power expansion while controlling for time-invariant local characteristics.

Because the outcome variables differ in time coverage, the panel has different lengths when all variables are combined. Separate estimation samples are therefore constructed depending on the dependent variable. The wind capacity data span a longer period (2003–2024), enabling the analysis to capture both early and mature phases of wind power expansion, while inequality and employment outcomes are observed over shorter but overlapping windows. The former contains data between the years 2011 and 2023, while the latter presents data from 2004 to 2018.

The panel provides two key sources of variation relevant for identification:

1. Between-municipality differences in exposure to wind power, reflecting geographic suitability and political approval.
2. Within-municipality changes over time as new installations are constructed.

It is important to note that this dataset does not distinguish between the construction and operational phases of wind power projects, in contrast to Slattery et al. (2011), Okkonen and Lehtonen (2016), Ejdemo and Söderholm (2015), and Arnborg (2021). This means that the estimated effects should be seen as the sum of the effects of both construction work and the presence of operations that follow. Consequently, discrepancies in results relative to studies that differentiate these phases may partially indicate this aggregation.

6.2 Municipality Characteristics and Descriptive Statistics

It has been shown above that the share of wind power produced electricity has increased in Sweden and that the total capacity has been on a similar trajectory in the past twenty years. While the national level characteristics are important and interesting, the real contribution as well as the basis of this analysis lies in the more granular, municipal level properties. This section will present exactly that.

In Sweden, there are a total of 290 municipalities, 193 of them present at least one wind turbine, meaning that the phenomenon analyzed affects 66 percent of the entire sample. In the table that follows (Table 1), the main descriptive statistics are shown, where a clear picture of the current state of Swedish municipalities is drawn. It can be seen that both the population density and population size present substantial variation across municipalities; more interestingly, there is also a difference between the median and mean, indicating skewness. This heterogeneity is relevant for the analysis, as both wind power siting and economic outcomes may differ systematically between rural and urban areas. Wind power capacity also displays substantial variation across municipalities. The mean installed capacity is 27.18, while the median is much lower at 4.68, meaning that a small number of municipalities host very large installations. The number one municipality is Piteå with a total capacity of 2068.87 MW, which is more than double the second highest municipality, Sollefteå with 914.76 MW. This skewness underscores the importance of using per-capita measures and fixed effects to account for structural differences across municipalities. On a different note, the GINI coefficient presents a more stable scenario, where the mean and median are almost the same value, and a sample variation from 0.21 to 0.44, consistent with moderate but non-negligible income inequality at the local level.

Table 1: Descriptive Statistics

variable	Description	Mean	Median	SD	N
Wind capacity (MW)	Installed wind power capacity	27.18	4.68	77.81	4053.00
Wind potential	Yearly average wind speed	6.67	6.56	0.55	4053.00
Population	Total municipal population	33691.11	16255.00	53366.30	4053.00
Population density (inh/km²)	Residents per square kilometer	64.91	26.10	174.98	4053.00
Tertiary education share	Share with tertiary education	0.21	0.19	0.08	4053.00
Per capita municipality income (SEK)	yealy per capita income at the municipality level	310860.95	306506.30	35423.75	4053.00
Gini coefficient	Income inequality (0–1)	0.25	0.24	0.02	2509.00
Urban share	Share of municipality that is urban	0.01	0.00	0.01	4053.00
Neighboring wind capacity per 1000 inh.	Neighboring spillover measure	1.83	0.36	4.34	4053.00
Unemployment rate	Share of unemployed individuals	0.07	0.07	0.03	3088.00
Early adopter (dummy)	1 if wind installed before 2003	0.68	1.00	0.46	4053.00
Right-wing municipality (dummy)	1 if right-wing majority	0.27	0.00	0.44	4053.00
Northern municipality (dummy)	1 if located in northern Sweden	0.19	0.00	0.39	4053.00

NOTE: Dummy variables take value 1 if the condition holds. The Gini coefficient, tertiary education share, urban share and unemployment rate range from 0 to 1. Neighbouring wind capacity is a first-order queen continguity spatial lag of the wind capacity variable. Per capita municipality income is shown in Swedish Krona (SEK) The sample includes 193 municipalities over the period 2003–2024, apart for the GINI coefficient and unemployment rate where the periods are respectively 2011-2023 and 2008-2023

It is important to acknowledge the dataset's limitations. First, the GINI coefficient and Employment data have a shorter timeframe compared to the wind capacity; they are, in fact, restricted to the period 2011-2023 and 2004-2018, respectively. This shrinks the panel when combining the various outcome variables and restricts the analysis of the long-term distributional effects of wind power expansion. Second, proxy measures are used for the urban share variable. Third, the inability to distinguish between construction and operational phases of wind power projects may affect comparability with studies that explicitly separate these channels. Finally, even though the use of a spatial weights matrix accounts for neighboring spillovers, based on a specific definition of geographic proximity, it might not be able to capture the economic connection of municipalities. Even with these limitations, which are common in the related literature, by following established empirical approaches in the field, the dataset provides a comprehensive and consistent basis for analyzing both the direct and heterogeneous effects of wind power expansion across Swedish municipalities.

7. Results

7.1 Selection into Wind Power Adoption

As previously mentioned, a central concern in this analysis is that wind power installations are not randomly distributed across municipalities. Locations with higher wind potential, different economic structures, or distinct political characteristics may be more likely to adopt wind power. This creates a potential selection problem, as municipalities with and without wind farms may differ systematically in ways that also affect the outcomes of interest. To assess the extent of this selection, a probit model is estimated where the dependent variable gets a value of 1 if a municipality has ever adopted a wind farm or 0 otherwise. The explanatory variables include wind potential, a set of socioeconomic characteristics such as population density, income, education, and labor market conditions, but also the geographical location of the municipality. From Table A1 in the Appendix, the results show that wind potential is a strong and statistically significant predictor of adoption, alongside the income, urban share, and education share of the municipality, which also presented statistical significance. The result on income is especially relevant for this analysis as it shows that municipalities with lower income levels are statistically more likely to adopt wind power. In fact, wind power installations are disproportionately located in the relatively poorer municipalities, corroborating that wind power deployment is non-random and correlated with observable factors. From a distributional point of view, this pattern is relevant in that it suggests that the economic impacts of wind power expansion may be distributed unevenly across municipalities, and municipalities with different initial income levels may be affected differently. These results also point to the importance of taking into account endogeneity in the estimation strategy; in particular, they provide motivation for the instrumental variable approach adopted in this study, which exploits exogenous variation in wind capacity driven by wind potential.

7.2 Results for Hypothesis 1: Municipal Gains and Heterogeneity

Before showing the main results for Hypothesis 1, it is of great relevance to show the first stage results, equation 3, of the basic model. From Table A2 in the Appendix, it can be noted how the F-value of the instrument is roughly 181, which signifies a lack of evidence of a weak instrument. The Hausman test has been employed as well, and it presented a p-value well below the 0.05 threshold, suggesting that a fixed effect model, like the ones that this panel analysis utilizes, is to be preferred compared to random effect models. An event study analysis was also conducted in order to assess the validity of the parallel trends assumption underlying the empirical strategy. As can be noted in Figure 4 in the Appendix, there is no statistical significance in the pre-treatment coefficients, which supports the assumption that treated and untreated municipalities followed similar income trends prior to wind

power adoption. Moreover, Table A3 in the Appendix presents a placebo test, which is used to test the exclusion restriction, and it yields no significant relationship between the instrument and income prior to treatment, supporting the restriction. Finally, in Figure 5 in the Appendix, a leave-one-out robustness exercise has been presented, where each time one municipality was removed and the baseline IV was calculated. The estimated coefficients remain highly stable across specifications, indicating that the results are not driven by influential observations or individual municipalities.

Across all the specifications that follow in Table 2, Table 3, Table 4, and Table 5, a distinction should be made between the overall adjusted R-squared and the adjusted within R-squared. In fixed-effects panel models, the overall R-squared reflects the explanatory contribution of municipality and year fixed effects, which absorb a substantial share of persistent cross-sectional and temporal variation. By contrast, the within R-squared measures explanatory power based only on within-municipality variation over time after fixed effects have been removed (Wooldridge, 2012). Since the empirical strategy relies primarily on within-municipality variation for identification, the within R-squared is the more informative measure of model fit in this context.

The following table, Table 2, presents the basic model with the logarithm of each municipality' income per capita as the dependent variable, which it has been previously shown as equation 1, where in the first column (Model 1) contains only the basic controls while the second column (Model 2) contains a political dummy ("Right-wing municipality") which has a value of one if the municipality in the previous municipal elections voted to right-leaning parties with a winning majority or a value of 0 if the opposite happened. Model 2 also contains the spatial weight matrix ("Neighbouring wind capacity per 1000 inh."), which accounts for the neighboring municipalities' wind capacity, in an attempt to capture spillover effects.

Table2: Municipal gains (Hypothesis 1)Dependent variable is log of income per capita and standard errors in parenthesis.

	Model 1	Model 2
Wind Capacity per 1000 inh.(log)	-0.026**	-0.030**
	(0.011)	(0.013)
Population (log)	0.028	0.044
	(0.103)	(0.102)
Population density (log)	-0.070	-0.080
	(0.079)	(0.080)
Tertiary education share	0.614***	0.620***
	(0.213)	(0.220)
Income trend since 2003	-0.009**	-0.010**
	(0.004)	(0.004)
Right-wing municipality(dummy)		-0.001
		(0.003)
Neighboring wind capacity per 1000 inh.		0.001
		(0.001)
Num.Obs.	4053	4053
R2 Adj.	0.977	0.977
R2 Within Adj.	0.159	0.162
Std.Errors	by: municipality_code	by: municipality_code
FE: municipality_code	X	X
FE: year	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: this table represents the basic specification of the model, Model 1, in Model 2 the political dummy variable and the spatial weight matrix are added.

The coefficient of wind power capacity presents a negative sign in all models, and in the baseline model (Model 1), it is statistically significant at the 5 percent level, indicating that a 1 percent rise in per capita wind power capacity correlates with an approximate 0.026 percent reduction in average municipal income per capita. The effect is small in magnitude, but the negative sign is the same in all specifications and stays marginally significant even when more controls are added. These results are robust to alternative specifications such as First-difference and Long-difference models, similar to Brown et al. (2012) and Xia and Song (2017), even though in those two models the instrument presented in this thesis becomes weak. Worth mentioning is that I have decided not to add the unemployment rate as in Brown et al. (2012) and Xia and Song (2017) because the data will have shrunk the time frame (from 21 to 16 years) and, as Table A4 in the appendix shows, the results remain the same with and without the said variable. A further specification using yearly changes in wind capacity as the dependent variable, closer to the approach in Brown et al. (2012) and Xia and Song (2017), yields similar results (see Table A5 in the Appendix), but again weakens the instrument chosen for the analysis in this thesis; for this reason, Table 2 is retained as the preferred specification. The stability of the coefficient across specifications suggests the result is not driven by model

specification. Most control variables, such as population size and density, are not statistically significant. On the other hand, the share of highly educated people is positively linked to income, which was expected, with the coefficients being around 0.6; moreover, the control variable for income trends stays at the same significant level (5 percent) in both models, with the same sign and almost the same coefficient. The high overall adjusted R-squared values primarily reflect the importance of municipality and year fixed effects, indicating substantial persistence in regional economic characteristics across Swedish municipalities. The lower adjusted within R-squared values suggest that the explanatory variables account for a modest but non-negligible share of within-municipality variation over time, which is consistent with expectations in fixed-effects panel settings.

Overall, these findings suggest that wind power expansion is associated with a small negative effect on municipal income, although the magnitude is modest. When the results in Table 2 are considered together with the ones found in Table A1, where lower-income municipalities are more likely to adopt wind power, the negative coefficient on wind power capacity raises potential concerns about distributional effects. In particular, if wind power expansion is concentrated in relatively poorer municipalities and is associated with a small reduction in income, this raises the possibility of distributional effects across municipalities.

On the same topic, Table 3, where the dependent variable is, as in Table 2, the logarithm of each municipality's income per capita, presents the basic model of Table 2 but with interaction terms for: the municipal density, meaning that it separates municipalities based on the population density, where the threshold is the median. The political dummy, where municipalities are differentiated based on the voting results of the previous municipal elections, the income dummy separates the municipalities based on whether their income is above or below the national median, and the adopter dummy is employed to account for the year of first implementation, where the cutoff is set at 2003. This specific year has been chosen because 92 municipalities already had or started implementing wind power in that year, meaning that the sample is split almost exactly in half, and because in 2003, the electricity certificate system was introduced. The penultimate interaction is done by employing a north dummy, where the value of such a variable is one if the municipality is located in northern Sweden and zero if otherwise, while the last interaction is done by utilizing a dummy that captures if the municipality is in the bottom quartile of the income distribution. The interaction terms are used to capture possible heterogeneous effects, which are what the first hypothesis investigates.

Table 3: Heterogeneous effects (Hypothesis 1) Dependent variable is log of income per capita and standard errors in parenthesis.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Wind Capacity per 1000 inh.(log)	0.0069	-0.0264**	-0.0167	-0.0236**	-0.0383**	-0.0304***
	(0.0094)	(0.0120)	(0.0117)	(0.0109)	(0.0156)	(0.0117)
Interaction: Capacity × Density	-0.0181***					
	(0.0053)					
Population (log)	0.0459	0.0277	0.0360	0.0191	0.0780	0.0530
	(0.1050)	(0.1031)	(0.0912)	(0.1000)	(0.0820)	(0.0794)
Population density (log)	0.0864	-0.0705	-0.0578	-0.0634	-0.0527	-0.0386
	(0.0694)	(0.0796)	(0.0599)	(0.0700)	(0.0507)	(0.0419)
Tertiary education share	0.4964**	0.6135***	0.5658***	0.6317***	0.5284**	0.4959***
	(0.2319)	(0.2132)	(0.2004)	(0.2139)	(0.2088)	(0.1901)
Income trend since 2003	-0.0076*	-0.0093**	-0.0025	-0.0098**	-0.0117***	-0.0025
	(0.0044)	(0.0041)	(0.0055)	(0.0043)	(0.0039)	(0.0046)
Interaction: Capacity × Right-wing		-4.52e-05				
		(0.0050)				
Interaction: Capacity × Income			-0.0226**			
			(0.0104)			
Interaction: Capacity × Adopter				-0.0083		
				(0.0082)		
Interaction: Capacity × North					0.0236***	
					(0.0090)	
Interaction: Capacity × Low Income						0.0232***
						(0.0070)
Num.Obs.	4053	4053	4053	4053	4053	4053
R2 Adj.	0.978	0.977	0.978	0.977	0.978	0.978
R2 Within Adj.	0.189	0.161	0.171	0.159	0.170	0.183
Std.Errors	by: municipality_code	by: municipality_code	by: municipality_code	by: municipality_code	by: municipality_code	by: municipality_code
FE: municipality_code	X	X	X	X	X	X
FE: year	X	X	X	X	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: this table represents the basic specification presented in Table 2 but with an interaction term for the municipal density (Model 1), political dummy (Model 2), income dummy (Model 3), adopter dummy (Model 4), north dummy (Model 5) and and a bottom-income dummy (Model 6), where the dummy variable equals one for municipalities in the bottom quartile of the income distribution.

The results from Table 3 indicate that the baseline effect of installed wind power capacity on municipal income remains small, negative, and generally statistically significant across specifications, except for Models 1 and 3. However, introducing interaction terms, which is the purpose of the specifications, reveals important heterogeneity. In particular, the interaction with population density is negative and statistically significant (with a coefficient of -0.0181), suggesting that the negative effect of wind power capacity becomes stronger in municipalities that have a higher population density than the median value at the national level. A similar result can be observed when the interaction term is paired with the income level, with a negative, statistically significant coefficient of -0.0226, showing that the negative effect is amplified in municipalities that have a higher income compared to the median income. Moreover, the interaction term for municipalities located in the bottom quartile of the income distribution is positive and statistically significant at the 1 percent level, with a coefficient of 0.0232. Meaning that lower-income municipalities appear to experience relatively more favorable income effects from wind power expansion compared to municipalities with higher income levels. Lastly, the interaction with the northern dummy is positive and significant with a coefficient of 0.0236, indicating that municipalities in northern Sweden experience relatively more favorable effects. The interaction terms for political orientation and adopter status are negative but not statistically significant, providing limited evidence of differential effects along these dimensions. In order to assess the economic significance of the results, it is useful to interpret the coefficients as elasticities, since both income and wind capacity are expressed in logarithms. Across specifications, the baseline effect ranges from approximately −0.02 to −0.04, implying that a 10 percent increase in wind capacity is associated with a decrease in income of about 0.2 percent to 0.4 percent. While it is statistically significant in many models, this magnitude is relatively small, which suggests that the direct effect of wind power expansion on income is economically limited. Among the control variables, the share of educated individuals stands out as economically the most important determinant of income. With coefficients around 0.5 – 0.6, a 10 percentage point increase in the education share is associated with approximately a 5 – 6 percent increase in income, which is an order of magnitude larger than the effects associated with wind capacity. This highlights that, while wind power may have statistically detectable effects, human capital remains the primary driver of income differences across municipalities. Similar patterns to Table 2 are observed in Table 3 when it comes to the high overall model fit, which reflects persistent structural differences across municipalities, while the adjusted within R-squared values indicate that the specifications explain a moderate share of within-municipality temporal variation. This pattern is consistent with the geographically persistent nature of many regional economic indicators examined in the analysis.

Overall, the findings suggest that the impact of wind power expansion is not uniform but depends primarily on spatial characteristics such as population density and geographic location, but also on the wealth of the municipality, hence supporting the first hypothesis.

7.3 Results for Hypothesis 2: Income Inequality

Table 4, which follows, presents equation 4, where the dependent variable is the GINI index, and equation 5, where the dependent variable is the yearly changes in the GINI coefficient. It shows the effects of wind power expansion on the GINI coefficient in Model 1 and its yearly changes in Model 2, investigating whether there are within-municipality inequality effects, which represent Hypothesis number 2 of the analysis. The two specifications are presented in order to examine whether wind power expansion affects either the overall level of inequality or the evolution of inequality over time.

Table 4: Income inequality (Hypothesis 2) Dependent variable is GINI coefficient (Model 1) and yearly change in GINI coefficient (Model 2) and standard errors in parenthesis.

	Model 1	Model 2
Wind Capacity per 1000 inh.(log)	-0.0001	-0.0025
	(0.0027)	(0.0015)
Population (log)	0.0072	0.0103
	(0.0273)	(0.0175)
Population density (log)	-0.0127	0.0004
	(0.0223)	(0.0156)
Tertiary education share	-0.0445	0.0309
	(0.0649)	(0.0386)
Income trend since 2003	0.0049***	-0.0014**
	(0.0017)	(0.0007)
Right-wing municipality(dummy)	-0.0019**	-0.0012**
	(0.0009)	(0.0005)
Neighboring wind capacity per 1000 inh.	4.23e-05	0.0001**
	(0.0001)	(6.74e-05)
Num.Obs.	2509	2316
R2 Adj.	0.777	0.021
R2 Within Adj.	0.013	-0.001
Std.Errors	by: municipality_code	by: municipality_code
FE: municipality_code	X	X
FE: year	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: Model 1 presents the effects of wind expansion on the GINI coefficient while Model 2 presents the effects of wind power expansion on the yearly changes in GINI.

The results show that, across both specifications, there is no strong evidence that wind power expansion significantly affects intra-municipal inequality. The first column of the specification (Model 1) shows the dependent variable as the level of the GINI coefficient. The estimated coefficient on wind power capacity is close to zero and not statistically significant, which means that increases in wind power capacity do not have an economically meaningful effect on the overall level of income

inequality in municipalities. When concentrating on the changes in inequality over time (Model 2), the findings indicate that the coefficient is not statistically significant, providing no evidence of an effect. From Table 4, it can also be observed that the dummy accounting for the municipality's political orientation stays significant and with the same negative sign in both Model 1 and Model 2, with the coefficient being 0.0019 and 0.0012, respectively. The income trend variable has the opposite sign, and it is statistically significant in the two models; however, more interestingly, the neighbouring wind capacity variable becomes significant at the 5 percent level in the second model with a coefficient of 0.0001, suggesting that spillover effects can be observed on the yearly change of the GINI coefficient. Table 4 displays substantially lower adjusted within R-squared values relative to the previous specifications in Tables 2 and 3, including one slightly negative adjusted within R-squared. This reflects the limited explanatory power of the regressors for short-run within-municipality variation after municipality and year fixed effects are absorbed. Because adjusted R-squared penalizes the inclusion of additional regressors, values close to or below zero may arise in fixed-effects panel models when the explanatory variables contribute little additional within-unit explanatory power beyond the fixed effects. In this setting, the primary objective of the analysis is causal estimation of the treatment effect rather than maximizing predictive fit.

Overall, these findings provide no support for Hypothesis 2. There is, in fact, no evidence suggesting that wind power expansion may reduce or increase the growth of inequality measured by the GINI index; the lack of robust and economically meaningful effects suggests that wind power does not play a major role in shaping income distribution at the municipal level.

7.4 Results for Hypothesis 3: Labor Market Effects

Table 5 reports the instrumental variable estimates of the relationship between wind power expansion and local labor market outcomes. The analysis is presented both without sectoral fixed effects (Model 1) and with sectoral fixed effects (Model 2). Sector fixed effects control for time-invariant heterogeneity across sectors, which is unrelated to wind power expansion, such as systematic differences in average employment shares between the three different sectors. Model 3 follows the specification of Model 2 but uses sectoral employment levels as the dependent variable. The employment is divided into primary, secondary, and tertiary sectors, where the primary sector is omitted from the regression and therefore serves as the reference category, meaning that the coefficients on the secondary and tertiary sectors should be interpreted relative to employment in the primary sector. The primary sector includes agriculture and related activities, the secondary sector contains manufacturing and construction, while the tertiary sector includes services.

Table 5: Labor Market Effects (Hypothesis 3) Dependent variable is sectoral share in Model 1 and Model 2, sectoral employment levels in Model 3 and standard errors in parenthesis.

	Model 1	Model 2	Model 3
Wind Capacity per 1000 inh.(log)	0.0134**	0.0075	0.0254
	(0.0060)	(0.0098)	(0.1093)
Log Capacity per 1000 inh. x Secondary	0.1070***	-0.0395***	-0.2187*
	(0.0137)	(0.0090)	(0.1150)
Log Capacity per 1000 inh. x Tertiary	-0.0498***	-0.0018	0.0192
	(0.0059)	(0.0109)	(0.1299)
Population (log)	-0.0222	-0.0222	0.5524*
	(0.0192)	(0.0182)	(0.2596)
Population density (log)	0.0037	0.0037	0.2037*
	(0.0132)	(0.0129)	(0.1090)
Tertiary education share	-0.0485	-0.0485	0.1792
	(0.0304)	(0.0309)	(0.3913)
Right-wing municipality(dummy)	-0.0003	-0.0003	-0.0065
	(0.0003)	(0.0002)	(0.0059)
Num.Obs.	31845	31845	31845
R2 Adj.	0.171	0.635	0.892
R2 Within Adj.	0.169	0.003	0.002
Std.Errors	by: municipality_code	by: municipality_code & year	by: municipality_code & year
FE: municipality_code	X	X	X
FE: year	X	X	X
FE: sector		X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: This table shows in Model 1 the effects of wind power on the three different labor sectors without accounting for the sector fixed effects while Model 2 shows the same specification but accounting for the sector specific fixed effects. Model 3 shows the same specification as in Model 2 but with the dependent variable being the employment levels with sectoral fixed effects.

In Model 1, the coefficient on the secondary sector is positive and statistically significant at the 1 percent level, suggesting that wind power expansion is associated with an increase in the share of employment in the secondary sector relative to the primary sector. In terms of magnitude, a 1 percent increase in wind power capacity is associated with an increase of approximately 0.10 percentage points in the secondary sector employment share, indicating a small effect. However, this result does not persist when sectoral fixed effects are included, as presented in Model 2. The reversal in the coefficient sign suggests that the initial positive relationship was driven by persistent structural differences across sectors rather than by within-sector changes over time. In particular, sectors such as manufacturing and construction display systematically different employment structures relative to the primary sector, which are absorbed by the sector fixed effects. After accounting for this sector-specific heterogeneity, the estimated relationship between wind power expansion and secondary sector employment becomes negative. Turning to Model 3, which examines sectoral employment levels,

there is a weak, statistically significant relationship between wind power capacity and employment levels by the secondary sector at the 10 percent level. The estimates, however, are imprecise, making it difficult to draw strong conclusions about aggregate labor market effects. Table 5 shows a larger variation in explanatory power across specifications, in the first model, the similarity between the adjusted overall and adjusted within R-squared values suggests that within-municipality temporal variation contributes relatively more to the model's explanatory power compared to the other specifications. By contrast, columns 2 and 3 display high overall adjusted R-squared values but near-zero adjusted within R-squared, indicating that most explanatory power is generated by municipality and year fixed effects rather than by short-run within-municipality variation in the included regressors.

Taken together, the results provide limited support for Hypothesis 3. There is no consistent evidence of systematic shifts in employment across sectors or of broader effects on total employment. This, at first glance, might be perceived as contradicting the first result, which presented that wind power expansion is associated with a small negative effect on municipal income, however this might not necessarily be the case. The income effect might, in fact, operate through channels other than aggregate employment, such as lower wage growth or the distribution of economic gains outside the municipality. Moreover, the estimated income effects are relatively small in magnitude, meaning that they may not translate into detectable changes in sectoral employment patterns.

8. Discussion and Policy Implications

This section will present an interpretation of the empirical findings and a discussion with regard to their implications for policy design in the context of Sweden's renewable energy transition. It has been previously documented in this thesis that the effects of wind power expansion on local communities in Sweden are small in size, heterogeneous, and, in specific cases, appear not to exist in any way.

8.1 Discussion

The first finding is that wind power expansion is associated with a statistically significant, but negative effect on average municipal income; the effect is small in magnitude, but the negative sign is the same in all specifications and stays marginally significant even when more controls are added. The stability of the coefficient across specifications suggests the result is not driven by model specification. Moreover, when this finding is taken together with the ones from the probit model, showing how poorer municipalities have a higher chance of adopting wind farms in the first place, it raises potential concerns regarding the distributional effects of wind power across municipalities.

These findings differ from much of the previous literature documenting positive local economic effects from wind power investments, such as Slattery et al. (2011) and Okkonen and Lehtonen (2016). However, those studies examine wind power development in Texas, United States, and northern Scotland, respectively, suggesting that institutional and regional differences may partly explain the contrasting results.

The second relevant finding suggests that the impact of wind power expansion is heterogeneous; in fact, it depends on the municipality's observable characteristics. More specifically, it has been presented that the effects are negative and statistically significant when the municipalities have higher income and higher population density. The opposite has been found, positive and statistically significant effects, for municipalities that are in the bottom quartile of the income distribution and the ones located in Northern Sweden, while political orientation and the time of wind power adoption are suggested not to have an impact. This is consistent with theories from economic geography suggesting that place-based economic shocks generate uneven regional outcomes depending on local characteristics such as density, economic structure, and connectivity (Krugman, 1991; Fujita et al., 2001). It also supports the argument by Ejdemo and Söderholm (2015) that local conditions and benefit-sharing mechanisms shape how gains from wind power are distributed.

The third result is the absence of robust evidence that wind power expansion affects intra-municipal income inequality. In fact, across both the specification with GINI levels and with the yearly change in the GINI coefficient, the estimated effects are small and statistically insignificant. These indicate that wind power does not play a major role in shaping income distribution within municipalities. This finding contrasts with some theoretical expectations, which suggest that capital income from land leases and unequal access to employment opportunities could increase income dispersion. However, the empirical results suggest that such mechanisms may be offset by countervailing forces. It also contrasts with concerns raised in previous literature regarding uneven benefit distribution from renewable energy investments (Ejdemo and Söderholm, 2015; Topcu and Tugcu, 2020).

The fourth finding relates to local labor market outcomes, where the analysis provides limited evidence of systematic effects of wind power expansion on employment structure or sectoral employment levels. While the specification with sectoral share as a dependent variable suggests a positive association with employment in the secondary sector, these results are not robust to the specification with sectoral employment levels. These findings are consistent with the characterization of wind power as a capital-intensive technology with relatively low labor requirements, particularly in the operational phase. While construction activities may generate temporary employment, these effects are not sustained over time and may not be large enough to produce measurable changes in aggregate employment statistics at the municipal level. These findings are consistent with previous

literature characterizing wind power as a capital-intensive technology with relatively limited long-run employment effects (Slattery et al., 2011; Okkonen and Lehtonen, 2016; Ejdemo and Söderholm, 2015).

When taken together, the results of this study suggest that wind power expansion does not constitute a strong engine of local economic development in the Swedish context. Rather, its effects are modest in magnitude and heterogeneous across space, which influences the distribution and retention of economic benefits. This has important implications for policy design, particularly in the context of the ongoing green transition. This analysis concentrates on labor-market and income-related regional outcomes, but wind power expansion may generate other kinds of local economic and social effects that are not directly captured in the present framework. These effects could, for example, be changes in property and land prices, shifts in migration, impacts on tourism, and environmental amenities. These dimensions may be particularly important in rural municipalities where wind power projects constitute large spatial interventions. A comprehensive assessment of these mechanisms would require more spatially disaggregated data and a distinct empirical design, and therefore remains an important avenue for future research beyond the scope of this thesis.

Moreover, as mentioned in the Data section (6.2), four different limitations must be acknowledged: the GINI coefficient and employment data have a shorter timeframe compared to the wind capacity, proxy measures are used for the urban share variable, the inability of this analysis to distinguish between construction and operational phases of wind power projects and since the spatial weight matrix is based on a specific definition of geographic proximity, it might not be able to capture the economic connections of municipalities. In addition, since the dataset covers the period 2003–2024, the estimated relationships reflect the institutional, technological, and economic conditions prevailing during this timeframe, as a consequence, the effects of wind power expansion may differ under current or future conditions. Even with these limitations, by following established empirical approaches in the field and the fact that several robustness checks were conducted to assess the consistency of the results across alternative specifications and model assumptions, the dataset provides a comprehensive and consistent basis for analyzing both the direct and heterogeneous effects of wind power expansion across Swedish municipalities.

8.2 Policy Implications

From these findings, several policy implications emerge, the results suggest that the local economic benefits of wind power expansion are neither automatic nor evenly distributed, highlighting the importance of institutional design in shaping outcomes.

First, the negative association between wind power expansion and municipal income points to the need to strengthen local benefit retention. From the results, it can be noted that a substantial share of the economic value generated by a wind power project does not remain within the municipality, which could be a consequence of the Swedish fiscal equalization system, and also due to the ownership and profits often being concentrated outside the local economy. From a policy point of view, this means that if the economic benefits are not retained locally, municipalities might be less inclined to implement wind farms since there will be a lack of incentives to do so. Policymakers could strengthen the fiscal link between wind power production and municipal income to improve local welfare and acceptance.

Second, since the presence of heterogeneous effects has been shown, a uniform policy approach may not be the most effective; in fact, if regional characteristics are of great importance when determining the local economic impact of renewable energy investments, the policy design should take them into account. Place-based policies, such as targeted support for municipalities with weaker economic spillovers or complementary investments in infrastructure and local business development, could be a viable solution. This is because they can help ensure that the benefits of wind power expansion are more evenly distributed, while at the same time, in municipalities where the effects are less favorable, policy efforts may need to focus on mitigating potential trade-offs and ensuring compatibility with existing economic activities.

Finally, due to the lack of robust labor market effects, a limited role of wind power as a generator of sustained local employment has been highlighted. In fact, this finding suggests that the size of the economic impact of wind power expansion depends not only on whether an installation is present or not but also on how much it is integrated into the municipality's economy. Policymakers should reinforce measures that incentivize, for example, the use of local suppliers, investments in workforce training for technical and maintenance roles, and support in the development of complementary industries. This would create more direct links between wind power projects and the local economy, thus supporting growth in the multiplier effects of investments in renewable energy.

In summary, the above measures indicate that the increase of wind capacity is not sufficient to satisfy both environmental and economic goals, since the contribution of wind power expansion depends on how the economic benefits of wind power are distributed, retained, and integrated in local economies. Then, policies should recognize and take these dimensions into account to ensure the green transition is effective and inclusive.

9. Conclusion

This thesis contributes to the literature by providing one of the first nationwide, quantitative assessments of the regional development effects of wind power infrastructure in an advanced economy. By focusing on municipal inequality, labor market structure, and heterogeneous local effects, the study extends existing work on energy infrastructure and regional inequality. The analysis showed that wind power expansion is associated with a statistically significant, but negative effect on average municipal income; the effect is heterogeneous across municipalities that differ in population density, average income, and geographical location, which provides support for Hypothesis 1. On the other hand, there is little to no evidence of any effects on within-municipality inequality or on the municipal employment structure, showing a lack of support for Hypotheses 2 and 3. These findings provide valuable insights for policymakers since they emphasize that expanding wind capacity alone is insufficient to achieve both environmental and economic objectives. Policies should account for the local mechanisms mentioned in the text to ensure that the green transition is both efficient and inclusive.

Bibliography

Arnborg, A. (2021). Win-Wind Situation? The Local Labor Market and Wind Power Investments in Sweden.

Bartik, Timothy J. 1991. Who Benefits from State and Local Economic Development Policies? Kalamazoo, MI: W.E. *Upjohn Institute for Employment Research*. https://doi.org/10.17848/9780585223940

Bengtsson Ryberg, J., Bluhm, G., Bolin, K., Bodén, B., Ek, K., Hammarlund, K., Henningsson, M., Hannukka, I.-L., Johansson, C., Jönsson, S., Mels, S., Mels, T., Nilsson, M., Skärbäck, E., Söderholm, P., Waldo, Å., Widerström, I., & Åkerman, N. (2013). The effects of wind power on human interests: A synthesis. *Naturvårdsverket*, https://www.naturvardsverket.se/4ac36d/globalassets/media/publikationer-pdf/ovriga-pub/vindval/978-91-620-6545-4.pdf

Blanchard, O. J., Katz, L. F., Hall, R. E., & Eichengreen, B. (1992). Regional evolutions. *Brookings papers on economic activity*, 1992(1), 1-75.

Brown, J. P., Pender, J., Wiser, R., Lantz, E., & Hoen, B. (2012). Ex post analysis of economic impacts from wind power development in U.S. counties. *Energy Economics*, 34(6), 1743–1754. https://doi.org/10.1016/j.eneco.2012.07.010

Cedefop. (2026). Regional analysis and forecast system (RAPS). *European Centre for the Development of Vocational Training*. https://www.cedefop.europa.eu/en/tools/matching-skills/all-instruments/regional-analysis-and-forecast system-raps#:~:text=RAPS%20became%20operational%20in%202000.%20It's%20funded,Creating%20value%20for%20important%20institutions%20in%20society

da Conceição, P. S., da Silva, A. F., & dos Santos, M. J. S. (2024). Social Inequality and Renewable Energy: The Case of Afrodescendant Territories in Northeastern Brazil. *Revista de Gestão Social e Ambiental*, 18(12), 1–11. https://doi.org/10.24857/rgsa.v18n12-216

Ejdemo, T., & Söderholm, P. (2015). Wind power, regional development and benefit-sharing: The case of Northern Sweden. *Renewable and Sustainable Energy Reviews*, 47, 476–485. https://doi.org/10.1016/j.rser.2015.03.082

European Commission, (2026). Climate strategies & targets. Retrieved March 21, 2026, from https://climate.ec.europa.eu/eu-action/climate-strategies-targets_en

Eurostat, (2026). Gross and net production of electricity and derived heat by type of plant and operator. Retrieved March 2024, 2026, from https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_peh/default/table?lang=en

Fujita, M., Krugman, P. R., & Venables, A. (2001). The Spatial Economy: Cities, Regions, and International Trade. MIT Press.

Gagarin, H. (2022). Three Essays on Clean Energy Technologies and Implications for U.S. Policy.

Goldsmith-Pinkham, P., Sorkin, I., & Swift, H. (2020). Bartik Instruments: What, When, Why, and How. *American Economic Review*, 110(8), 2586–2624. https://doi.org/10.1257/aer.20181047

Hansen, L. P. (1982). Large Sample Properties of Generalized Method of Moments Estimators. *Econometrica*, 50(4), 1029–1054. https://doi.org/10.2307/1912775

Huynh, C. M., & Phan, T. N. (2024). Climate change and income inequality: Does renewable energy matter? *Renewable Energy*, 233, 121147. https://doi.org/10.1016/j.renene.2024.121147

International Energy Agency, (2025). Renewables 2025. Retrieved March 21, 2026, from https://iea.blob.core.windows.net/assets/76ad6eac-2aa6-4c55-9a55-b8dc0dba9f9e/Renewables2025.pdf#page=11.09

Jung, C. (2017). The politics of horizontal inequality: Indigenous opposition to wind farm development in Mexico (Working Paper No. 2017/146). WIDER Working Paper. https://doi.org/10.35188/UNU-WIDER/2017/372-1

Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*. (world). https://doi.org/10.1086/261763

Larsson, S., Emmelin, L., & Vindelstam, S. (2014). Multi-Level Environmental Governance: The Case of Wind Power Development in Sweden. *Societal Studies*, 6(2), 291–312. https://doi.org/10.13165/SMS-14-6-2-04

Liljenfeldt, J., & Pettersson, Ö. (2017). Distributional justice in Swedish wind power development – An odds ratio analysis of windmill localization and local residents' socio-economic characteristics. *Energy Policy*, 105(C), 648–657. https://ideas.repec.org//a/eee/enepol/v105y2017icp648-657.html

Lindvall, D. (2023). Why municipalities reject wind power: A study on municipal acceptance and rejection of wind power instalments in Sweden. *Energy Policy*, 180, 113664. https://doi.org/10.1016/j.enpol.2023.113664

Lundin, E. (2024). Wind power and the cost of local compensation schemes: A Swedish revenue sharing policy simulation. *Energy Economics*, 135, 107632. https://doi.org/10.1016/j.eneco.2024.107632

Lundin, E., & Von Platten, J. (2024). The Socioeconomics of Wind Power Expansion: Evidence from Sweden. SSRN. https://doi.org/10.2139/ssrn.5034838

McMillan, M., Rodrik, D., & Verduzco-Gallo, Í. (2014). Globalization, Structural Change, and Productivity Growth, with an Update on Africa. *World Development, Economic Transformation in Africa*, 63, 11–32. https://doi.org/10.1016/j.worlddev.2013.10.012

Moretti, E. (2010). Local Labor Markets (Working Paper No. 15947). *National Bureau of Economic Research*. https://doi.org/10.3386/w15947

Niskanen, J., Haikola, S., Magnusson, D., & Anshelm, J. (2024). Swedish wind power expansion: Conflicting responsibilities between state and municipalities. *Renewable and Sustainable Energy Reviews*, 206, 114881. https://doi.org/10.1016/j.rser.2024.114881

Okkonen, L., & Lehtonen, O. (2016). Socio-economic impacts of community wind power projects in Northern Scotland. *Renewable Energy*, 85, 826–833. https://doi.org/10.1016/j.renene.2015.07.047

Planning and Building Act (Plan- och bygglagen) (SFS 2010:900). (2010). Government of Sweden. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/plan--och-bygglag-2010900_sfs-2010-900

Renewable Energy Statistics 2025. (2025). https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2012/RE_Technologies_Cost_Analysis-WIND_POWER.pdf

Skatteverket, (2026). Property charge and property tax. Retrieved March 24, 2026, from https://www.skatteverket.se/servicelankar/otherlanguages/englishengelska/individualsandemployees/declaringtaxesforindividuals/owningrealpropertyinswedenlivingabroad/propertychargeandpropertytax.4.676f4884175c97df41923c6.html

Slattery, M. C., Lantz, E., & Johnson, B. L. (2011). State and local economic impacts from wind energy projects: Texas case study. *Energy Policy, Clean Cooking Fuels and Technologies in Developing Economies*, 39(12), 7930–7940. https://doi.org/10.1016/j.enpol.2011.09.047

Söderholm, P., & Pettersson, M. (2011). Offshore wind power policy and planning in Sweden. *Energy Policy*, 39(2), 518–525. https://doi.org/10.1016/j.enpol.2010.05.065

Söderholm, P., Ek, K., & Pettersson, M. (2007). Wind power development in Sweden: Global policies and local obstacles. *Renewable and Sustainable Energy Reviews*, 11(3), 365–400. https://doi.org/10.1016/j.rser.2005.03.001

Statistiska Centralbyrån, (2026). Kommunalekonomisk utjämning och utjämning av LSS-kostnader. Retrieved March 24, 2026, from https://www.scb.se/hitta-statistik/statistik-efter-amne/offentlig-ekonomi/finanser-for-den-kommunala-sektorn/kommunalekonomisk-utjamning-och-utjamning-av-lss-kostnader/#:~:text=Kommunalekonomisk%20utj%C3%A4mning%20utj%C3%A4mnar%20f%C3%B6r%20skillnader,beslutas%20och%20f%C3%B6rdelas%20av%20Skolverket

Sun, C., Li, X., & Zuo, X. (2026). Income distribution effect of renewable energy investment. *Energy Policy*, 209, 114945. https://doi.org/10.1016/j.enpol.2025.114945

Swedish Energy Agency, (2023). Installerad effekt per elomrade 2023. Retrieved March 24, 2026, from https://www.energimyndigheten.se/498dcd/contentassets/063e5666773c495fae288cb070467087/installerad-effekt-per-elomrade-2023_ny.svg

Swedish Energy Agency, (2025). Electricity Certificate System. Retrieved March 24, 2026, from https://www.energimyndigheten.se/en/climate/the-electricity-certificate-system/

Thellbro, C., Bjärstig, T., Svensson, J., Neumann, W., & Zachrisson, A. (2022). Readiness and planning for more wind power: Municipalities as key actors implementing national strategies. *Cleaner Energy Systems*, 3, 100040. https://doi.org/10.1016/j.cles.2022.100040

Thorstensson, F., & Karlsson, A.-M. (2015). STATISTIK FRÅN JORDBRUKSVERKET.

Topcu, M., & Tugcu, C. T. (2020). The impact of renewable energy consumption on income inequality: Evidence from developed countries. *Renewable Energy*, 151, 1134–1140. https://doi.org/10.1016/j.renene.2019.11.103

Westlund, H., & Wilhelmsson, M. (2025). Capitalisation of onshore wind turbines on property prices in Sweden: The need to compensate for negative externalities. *Economic Analysis and Policy*, 87, 1452–1468. https://doi.org/10.1016/j.eap.2025.07.025

Wooldridge, J. M. (2012). Introductory Econometrics: A Modern Approach.

Xia, F., & Song, F. (2017). Evaluating the economic impact of wind power development on local economies in China. *Energy Policy*, 110, 263–270. https://doi.org/10.1016/j.enpol.2017.08.030

Appendix: Alternative Specifications

A.1 Probit model

Table A1: Average marginal effects from probit model. Dependent variable is a dummy for whether the municipality ever adopted wind power. Standard errors in parenthesis.

	Model 1
Wind potential	0.390***
	(0.073)
Population density (log)	-0.022
	(0.041)
Income (log)	-1.583***
	(0.610)
Urban share	-8.459***
	(2.571)
Tertiary education share	1.513***
	(0.571)
Unemployment rate	-1.788
	(1.717)
Right-wing municipality (dummy)	-0.166
	(0.105)
Northern municipality (dummy)	0.128
	(0.099)
Southern municipality (dummy)	0.067
	(0.060)
Pseudo R^2 (McFadden)	0.223

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: The table reports average marginal effects (AMEs) from a probit model estimated to assess potential selection into wind power adoption.

A.2 First stage regression

Table A2: IV Diagnostics. Dependent variable is log of Installed wind power capacity 1000 inhabitants and standard errors in parenthesis.

	Model 1
Wind IV (Leave-One-Out)	-3.95e-05***
	(9.20e-06)
Population (log)	-2.8130
	(1.8606)
Population density (log)	-1.7122
	(1.8055)
Tertiary education share	5.0383
	(3.6031)
Income trend since 2003	-0.1448**
	(0.0670)
Num.Obs.	4053
R2 Adj.	0.731
R2 Within Adj.	0.269
Std.Errors	by: municipality_code
FE: municipality_code	X
FE: year	X
First-stage F-stat	181.1500

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: this table represents the first stage regression of Equation 2.

A.3 Event study and placebo test

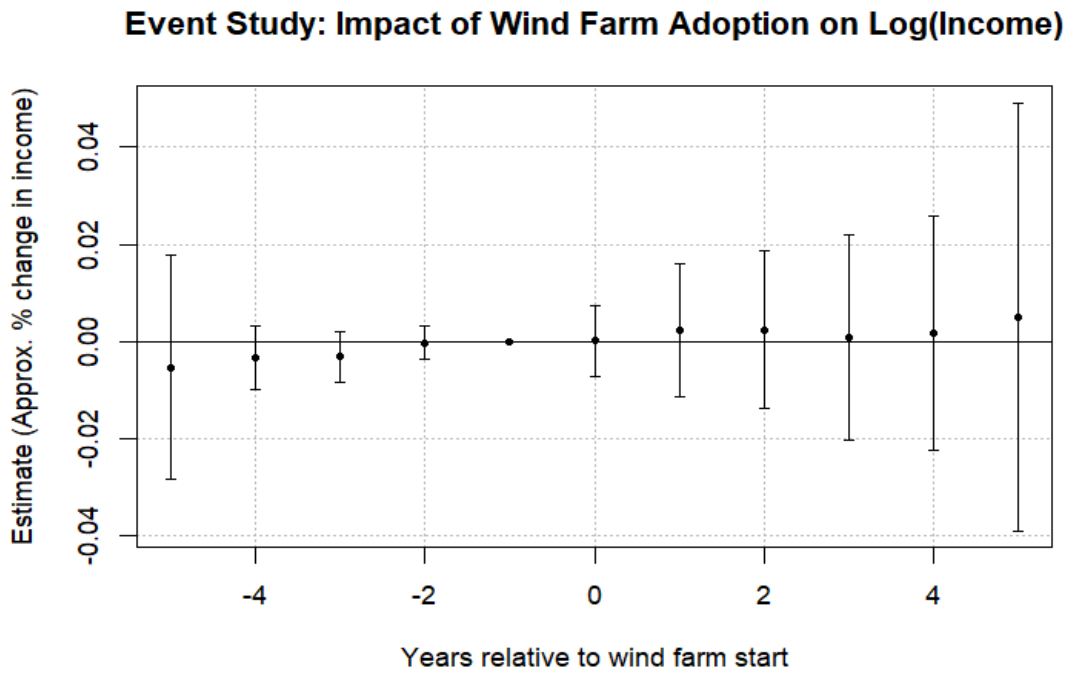


Figure 4: Impact of Wind Farm Adoption on Log(income)
NOTE: This figure presents the event-study estimates of the impact of wind farm adoption on log income relative to the year before adoption. The coefficients show the estimated change in income for each year before and after wind farm implementation, with 95% confidence intervals displayed. The absence of significant pre-treatment effects suggests no clear evidence of differential pre-trends prior to adoption.

Table A3: Placebo Test for Pre-treatment Trends. The dependent variable is log(income) and standard errors in parenthesis.

	Model 1
wind_iv_loo	1.91e-06
	(3.57e-06)
Num.Obs.	800
R2	0.982
R2 Within	0.019
Std.Errors	by: municipality_code
FE: municipality_code	X
FE: year	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: Note: This table reports a placebo test for pre-treatment trends. The explanatory variable is the leave-one-out wind instrument (wind_iv_loo) estimated using only pre-treatment observations. Municipality and year fixed effects are included in all specifications.

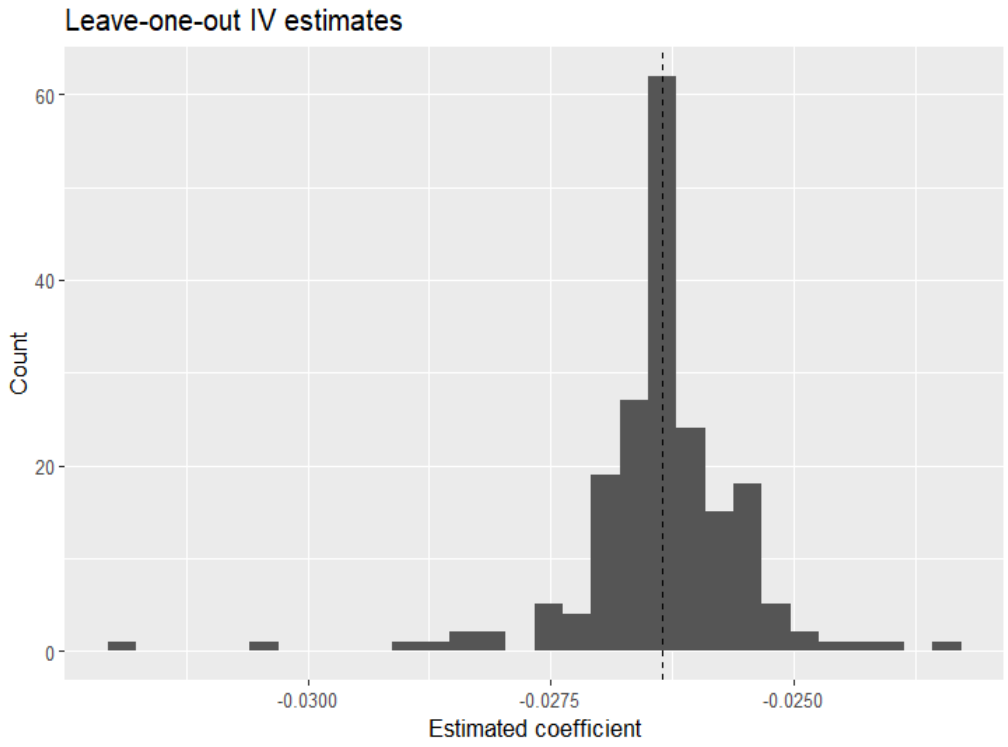


Figure 5: Leave-one-out IV estimates
NOTE: The figure presents the distribution of leave-one-out IV estimates obtained by sequentially excluding one municipality at a time from the baseline specification. The histogram shows the estimated coefficients on wind power capacity, while the dashed vertical line indicates the coefficient estimate from the full-sample model. The figure illustrates the robustness of the main result to the exclusion of individual municipalities.

A.4 Unemployment rate

Table A 4: Municipal gains and heterogeneity (Hypothesis 1) with Unemployment rate. Dependent variable is log of income per capita and standard errors in parenthesis.

	Model 1	Model 2
Wind Capacity per 1000 inh.(log)	-0.039**	-0.034**
	(0.015)	(0.015)
Population (log)	0.053	-0.019
	(0.136)	(0.127)
Population density (log)	-0.076	-0.080
	(0.123)	(0.114)
Tertiary education share	0.416*	0.525**
	(0.238)	(0.229)
Income trend since 2003	-0.019***	-0.016***
	(0.005)	(0.005)
Unemployment rate	-0.635***	
	(0.108)	
Num.Obs.	3088	3088
R2 Adj.	0.983	0.980
R2 Within Adj.	0.255	0.127
Std.Errors	by: municipality_code	by: municipality_code
FE: municipality_code	X	X
FE: year	X	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: this table presents the same setup as in Table 2 but it controls for unemployment rate as well, because of data availability the time frame is limited to 17 years rather than 21 years of Table 2. To detect whether unemployment rate has a significant effect, column 1 presents the 17 year sample without and column 2 presents the same sample with the unemployment rate, it can be noted that both the significance and sign on the main dependent variable do not change. Hence I have decided to stick with the bigger sample and drop the control.

A.5 Changes in wind capacity

Table A5: Municipal gains and heterogeneity (Hypothesis 1) Dependent variable is yearly changes in log of income per capita and standard errors in parenthesis.

	Model 1
Change in Wind Capacity per 1000 inh.(log)	-0.208**
	(0.102)
Population (log)	0.243**
	(0.118)
Population density (log)	-0.185
	(0.120)
Tertiary education share	0.457**
	(0.224)
Income trend since 2003	-0.003
	(0.006)
Num.Obs.	3860
R2 Adj.	0.977
R2 Within Adj.	0.153
Std.Errors	by: municipality_code
FE: municipality_code	X
FE: year	X

* p < 0.1, ** p < 0.05, *** p < 0.01

NOTE: this table presents the same setup as in Table 2 but in this case the dependent variable is yearly changes in wind capacity rather than wind capacity levels.