I. Introduction

The development of wind power generally arises from renewable electricity production and climate change mitigation. Both of the EU's 2020 renewable energy target and the Swedish government's national renewable target of 100% renewable electricity production encourage to increase the amount of renewable energy sources like wind power. In Sweden, there are two political block of parties which influence the use of wind power in various municipalities; The Left-Green political parties[1] and the Alliance parties[2] where the former commit to having a higher environmental ambition as compared to the Alliance (Swedish Society for Nature Conservation, 2018). Along with these prevailing two political block of parties, the Sweden Democrats party (that is now almost as popular as the Social Democratic party), however, gives more support to nuclear energy than to wind energy (Sverigedemokraterna, 2011).

In the early 1990s, wind power investments gradually started to increase through the introduction of complementary policy programs. The energy policy introduced in 1991 increased the reliance on renewable energy, and thus initiated the transition of the Swedish energy system towards a 100% renewable electricity production (Söderholm et al., 2007). Throughout the year 2003 to 2016, there has been a five-fold increase in the installation of wind power turbines in Sweden (see Figure 1). In 2018, 63% of renewable energy investments at the EU-level comes from wind energy, which is an increase from 52% in 2017. The investments of Sweden in onshore wind power amounted to €3.7bn in 2018. This has contributed to a 26% share in onshore wind power investments in Europe. Among the EU member states, Sweden is considered to be the second-largest investor in Europe. (WindEurope, 2018).

Wind power is a high capital intensive industry. In Sweden, wind power development obtains support through the national renewable target of 100% renewable electricity production by the year 2040. On behalf of the Swedish government, the Swedish Energy Agency distributes wind energy premiums worth 70 million SEK to municipalities per annum. The aim of this premium is to incentivize the Swedish municipalities and to assist the transition to a renewable energy system (Government Offices of Sweden, 2016 and 2017).

[1] Left-Green political parties consist of the Social Democrats, the Green Party and the Left Party.
[2] Alliance parties consist of the Moderate Party, the Liberals, the Centre Party and the Christian Democrats.

Across some EU countries[3] and various renewable electricity technologies, wind power investments face economic, institutional and political obstacles. The decision-making is influenced by the legal framework concerning the wind farms' planning, permitting and location (Söderholm & Pettersson, 2011). Permitting process is an example of a possible uncertainty that wind power project planners encounter, which is affected by the numerous amount of regulations. The amendments to regulations of wind power planning and probation are made in accordance with the Swedish parliament and government support to wind power expansion. The motivation behind these amendments is to, therefore, simplify the process of permitting (Swedish Energy Agency, 2010).

Ek (2005) points out, that from an environmental viewpoint, wind power seems to be advantageous in the context of increasing the use of a renewable energy source. The liberalization of the electricity market supports renewable energy sources, which in turn, enables electricity consumers to select renewable electricity. Despite this fact and generally positive attitudes towards wind power, local resistance against wind power development still seems to be a great obstacle. Also, Liljenfeldt (2017) states that the local population in a municipality participate in the wind power process whenever they have the opportunity, otherwise, they would somehow make a way to influence the planning process by networking and lobbying for instance. An interesting question can, therefore, arise- *which factors comprise this local resistance and to what extent does it influence the location of wind power establishments?*

Other important subjects in wind energy are wind characteristics and resources. Having knowledge about the characteristics of the wind in a particular location is of great importance especially on wind power's performance, operations, systems design and siting (Manwell et al. 2009). As discussed above, installing wind turbines do not mainly require an adequate wind resource on the location. It also relies on the mutual decision at the national and local level where conflict of aims can sometimes arise. It is therefore of interest to study the location of wind power investments from the socio-economic and political perspective.

[3] Comparison of wind power capacity is made among selected countries (Denmark, Germany, Spain, Sweden and the United Kingdom) in the context of national and global energy policies.

I.i Research question

Based on the discussion above, the economic problem of wind power is indirectly connected to the locals through the legal framework. Since Sweden has an ambitious goal in its renewable energy target, it is relevant to know how this target can be achieved through wind power support at the local level, which can be identified later in this study. Using the municipal level data over the time period 2003 to 2016, this study aims to identify if socio-economic and political factors can describe the diffusion of wind power establishments in Sweden. Factors such as unemployment, Left-Green parties' political stance, population density, size of a municipal area, wind resource and geographical location (coastal and mountainous areas) are examined to study wind power expansion in Sweden. A Probit and a Tobit model will be used. The first model aims to determine which factors might explain the location of wind farms while the second one aims to explain which factors are significantly related to its installed capacity.

This study is broadly related to that of Ek et al. (2013), where the authors find that wind power enthusiasts highly influence initial wind power investments, while large-scale investments might have been affected afterwards by market-based future profitability. The installed capacity is positively affected by having previous experience of wind power. Furthermore, Bergman et al. (2006) mention that the anticipated job opportunities in wind power development and the high unemployment rate might, therefore, have a positive effect.

The structure of this study goes as follows. In the next section, I discuss the wind power investment decision and public acceptance. Section III presents the empirical analysis, i.e. the data, model and method as well as the diagnostic test. The results are discussed in Section IV and in Section V, concluding remarks are provided.

II. Investment decision and public acceptance of wind power

This section discusses some aspects of wind power investment mechanisms related to the Tradable Green Certificate (TGC) support scheme and how wind power is perceived at the local level. The latter discusses the general attitudes towards wind power including public acceptance of wind power development (in terms of the legal framework concerning the planning, permitting and location of wind farms) as well as some externalities involved.

II.i National support schemes

According to the European Commission, a national support scheme is needed to achieve the ideal level of renewables in the EU and to increase renewable energy investment. It is also important to design the support schemes thoroughly so as to ensure the correct functioning of the energy market and to avoid higher costs for European households and businesses. Michanek and Söderholm (2006) state that the EU's renewable energy target receives further support through policy instruments like the TGC system, which is considered to be essential in new wind power investments. This system ensures that Swedish electricity consumers are contributing to phasing a certain proportion of renewable electric power in the electricity system.

Renewable power generators receive an "electricity certificate" per MWh of produced renewable electricity, which can then be sold in an open certificate market at a price without restriction. While the supply of certificates is unregulated, the demand is regulated through the quota[4] obligation of certificated electricity. Producers of wind power earn more for the certificates sold in addition to the wholesale electricity price (Söderholm et al., 2007). However, if the buyer of the certificate is an electricity supplier instead, the cost will be incorporated into the electricity price which is then charged to the customers (Swedish Energy Agency, 2017). In theory, this system should provide a minimum cost for renewable energy as low-cost generators are capable of selling their certificates (Voogt et al., 2000).

Söderholm & Pettersson (2011) state that the national policy instruments such as investment subsidy to pilot projects and the TGC system[5] may stimulate new offshore wind power establishments in Sweden. The investment subsidy to pilot projects refers to the investment program that the Swedish Energy Agency introduced in 2003. This program intends to promote large-scale wind power technological development. It also includes the onshore wind power establishment and some other selected projects that would guarantee such

[4] The quota is in proportion to the total use of electricity, which increases each year to guarantee an increase in the amount of renewable power. Certificates can generally be purchased by consumers via electricity suppliers who are obligated to fulfill the quota (IEA, 2014).

[5] This system has replaced the national environmental bonus (Söderholm and Pettersson, 2011) for wind power, which phased-out in 2009 (Ek and Persson, 2014). It was introduced in 2003 to increase renewable electricity production cost-effectively (Swedish Energy Agency, 2017).

development. Furthermore, the TGC system does not only guarantee the renewable electric power sources planned market share but it also aims to improve cost-effectiveness in the competition among various renewable energy sources.

A report from the Swedish Energy Agency (2016) states that wind turbines have become more cost-efficient due to the continuous production of improved (increased) wind turbine capacity. This improvement pushes down electricity and electricity certificate prices. As a result, this low revenue in relation to production cost implies that not all wind power projects can be implemented over the next few years. Hence, those projects that would invest in Swedish wind power are those with abundant wind resources, low costs and low required return. According to their short-term forecast, wind power development is still expected to continue, but with a lower growth rate.

II.ii Wind power at the local level

The physical wind resource is certainly one of the essential factors in wind power deployment but the investment also requires a sufficiently high compensation based on the energy certificates and electricity price (IVA, 2016). However, the wind itself limits wind energy production which makes the output from wind generators volatile. There will be short-run price volatility once wind power achieves a significant share in the electricity market as a result. That is, prices tend to be lower than normal with high wind generation and vice versa (Green and Vasilakos, 2011).

By analyzing the geographical aspect (e.g. the coastal and mountainous attributes) of a location, one can determine how the physical characteristics of the wind in an area would support wind power establishments. Toke et al. (2008) state that the size of a nation's wind power programme is naturally determined by the quantity of wind resources. According to Ek et al. (2013), there is a link between good wind resources and wind power existence as well as its installed capacity. As observed, the coastal areas in the southeast and southwest of Sweden have the highest amount of installed wind power capacity. They also find that the initial wind power investments seem to be influenced by wind energy supporters and future profitability has become more and more crucial in subsequent investments.

Aside from coastal areas, the good wind resource in mountainous areas enables the installment of wind power turbines. However, Ek and Persson (2014) find that offshore wind farms are mostly preferred over wind farms located in mountainous areas. Installing wind power turbines might possibly involve environmental impacts such as landscape intrusion and destruction of flora and fauna. For this reason, the physical attributes of mountainous areas can also oppose wind power development.

Investors face planning problems and local resistance against building renewable electricity plants, like wind power (Voogt et al., 2000). Environmental goals that stimulate the use of policy instruments are not often envisaged at the permitting and local planning, although policy instruments at the national level are strong enough to encourage wind power investments. In Sweden, the future of wind power development faces considerable hindrances such as public resistance against planned windmills as well as the legal framework concerning the windmills' planning, location and usage. Hence, wind power development is mainly affected by investment uncertainties regarding criticism from local opposition, the need for stable policy and legal provisions that controls the evaluation of wind power's environmental impact and its planning process (Söderholm et al., 2007). Huijts et al. (2012) point out the importance of considering the local population's perception of wind power establishments. This can then potentially give insights on how wind power projetcs can be designed and communicated in accordance with the local population.

Wind power investments rely accordingly on municipality's and local residents' decisions as well as perception on wind power projects. The permit procedure involves the municipality, Environmental Permit Office, Land and Environmental Court, government and the project planner. A permit from the County Administrative Board is required in installing more than 7 wind power turbines with a height exceeding 120 meters. Prior to the permit application, the municipality should file a recommendation in accordance with the Swedish Environmental Code. This consequently gives each municipality the right of veto for their decision (Swedish Environmental Protection Agency). The Environmental Permit Office, as well as the Land and Environmental Court, are responsible for planned projects regarding onshore and offshore wind power projects. The Swedish government also decides for wind power establishments within its economic zone. Finally, the project planner is liable for permit application and consultation with the municipality, County Administrative Board and other concerned participants regarding environmental impact assessment (Swedish Energy Agency, 2015).

The time it takes to implement wind power projects varies due to the decisions of different stakeholders. The actualization of a project depends not only upon prioritization and planning but it is also a political concern. The authorities have to make a decision on the permit application within 6 months, but in practice, it can last for more than a year (Wizelius, 2015). According to the Swedish Energy Agency (2018), the start up time for wind power installation is stated in the permit and it usually ranges between 5 to 7 years but for some permits, it can take up to 10 years. Furthermore, Liljenfeldt (2017) points out that it is important to consider the local oppositional interest groups as they are willing to participate in local planning processes when possible. Whenever these groups are excluded from this process, they will still manage to become influential through lobbying and networking. This can eventually hinder wind power development at the local and policy level. In effect, one can indeed argue that the social factor of population and the municipal area can have a direct or indirect connection to the development of wind power. Wind power projects certainly face uncertainties in the permitting process and local opposition, which may directly influence the amount of time it takes before the actual installation occurs. Given these points, the social factor of population and a municipal area can play a significant role in wind power implementation.

On the other hand, Rygg (2012) states that the majority of the support to the development of wind power comes from local interests such as modernization, economic and employment opportunities rather than adopting a sustainable energy source. The potential objections against wind power might be some externalities like visual impact, use of the land and references to birds and wildlife. Additionally, Bergmann et al. (2006) find that jobs appear to be highly significant in the rural area relative to the urban area. The reason behind this might be the anticipation of job opportunities in that area. As a matter of fact, wind power expansion has already generated jobs locally. This involves the process of planning and implementation of projects (Swedish Wind Energy Association). The number of employed people in the wind power industry has increased from 3,300 in 2010 to about 7,000 in 2011. By 2020, this number is expected to increase to 11,000 people (WSP, 2012). For this reason, the socio-economic factor of unemployment can have a direct influence on wind power investments.

The most important feature of wind power is that there is no pollution involved in the production of electricity through wind turbines. However, the production (e.g. wind turbine building materials) of wind turbines *per se* has to be considered in calculating the external cost[6] of wind power technology. This is because wind turbine production also induces environmental externalities and its external costs can range from 0.05 to 0.25 Euro cent/kWh[7] (European Commission, 2003).

Amendments to improve how existing energy systems interact with the communities are needed. This is because social acceptance has become a major challenge in wind power expansion and it is not able to be solved by merely a consultation or community benefit funds such as local ownership. This acceptance, in this case, is determined by the extent of public participation, wind power projects characteristics (design and location) as well as the perceived distribution of costs and benefits. Other anticipated impacts of projects such as landscape intrusion and negative effects on health, property values and biodiversity are likewise crucial to social acceptance (Ellis and Ferraro, 2016).

III. Empirical Analysis

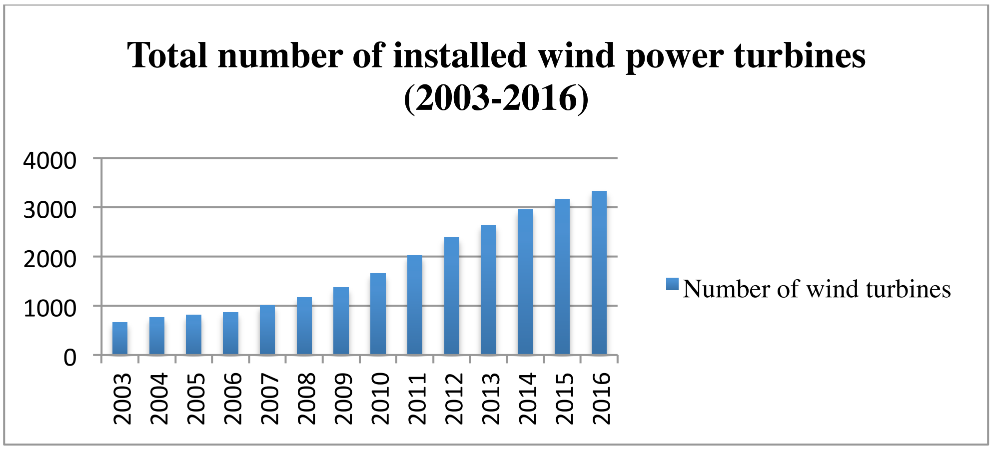
This study uses the Probit and Tobit model to analyze the location of Swedish wind power at the municipal level. For the Probit model, the dependent variable takes a value of 1 if a municipality has installed wind power turbines otherwise 0. The dependent variable for the Tobit model is the installed wind power capacity, which is measured in MW. It has a significant amount of zero-values that need to be censored and the Tobit model is, therefore, appropriate to use.

[6] Emission databases for the production of steel and concrete are used to compute the costs and impacts involved.
[7] The measurement unit is a sub-total of quantifiable externalities like material damage, public and occupational health, and global warming that has damage cost estimates from 18 to 46 Euro per ton of CO_2. In this study of the external cost of energy, the following countries are included: Austria, Belgium, Germany, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Sweden, and the UK.

III.i Data

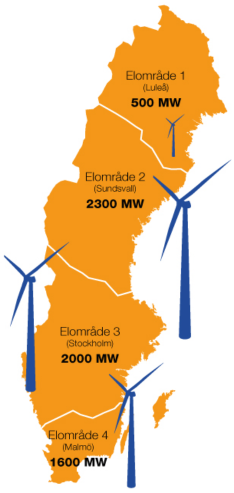
The data for the Probit and Tobit models include the entire 290 municipalities in Sweden, which ranges from 2003 until 2016 (see Table A1 in the Appendix for the list of municipalities with installed wind power turbines). Both offshore and onshore wind farms are included. The data for the number of wind turbines and wind power capacity (MW) are gathered from wind power statistics of the Swedish Energy Agency. The installed capacity is the theoretical standardized maximum capacity of a wind power plant and the data uses the sum of all capacity of wind power plants for every municipality. Figure 1 shows that the total number of installed wind power turbines has increased from 667 in 2003 to 3,334 in 2016. Figure 2 shows the approximate value of the installed wind power capacity in 2016 at four different Swedish electricity areas. These figures indicate a significant increase in the development and capacity of wind power.

Figure 1. Number of installed wind power turbines, 2003-2016



Source: Swedish Energy Agency (2016)

Figure 2. Approximate installed wind power capacity in 2016



Source: Swedish Energy Agency (2016)

The long process that takes place prior to the actual wind power installations makes it ideal to use a time-lagged variable for unemployment. This implies that the amount of unemployment rate data needs to cover the time period from 1998 to 2016, while the available data in the Swedish Public Employment Service ranges only from 2008 to 2018 (at the regional and municipal level). For that reason, I derive the unemployment rate by calculating the ratio between the number of registered unemployed people and the population[8] of people at ages between 15 to 64. Additionally, the data for the area (km^2) and population density at the municipal level are collected from Statistics Sweden.

The hourly-base data for the wind speed is gathered from all (220) active wind stations of the Swedish Meteorological and Hydrological Institute (*SMHI*). To convert this into annual data, the wind speed in a municipality per year is calculated by taking its mean-value per year.[9] The main drawback of using the mean-value is that it is sensitive to outliers or extreme values, especially when the sample size is small. In this study, the data for time-lagged wind speed has 1,390 number of observations, which can be considered as a large sample size.

---

[8] The age of people in the Swedish labour force is actually between 16 to 64 years old, but the population data is classified in 10-year intervals (i.e. 5-14 years,15-24 years etc.), therefore the population of the people at the age 15 has been included.

[9] Some municipalities do not have wind stations and some has more than one, which results into 114 municipalities with wind speed data. The conversion of hourly wind speed data to average yearly wind speed is suggested by the SMHI.

This study follows Bjärstig et al.'s (2018) 15 listed mountainous municipalities in Sweden. The list of coastal municipalities is collected from the Swedish website *Havet.nu*[10]. In addition, the data for the political stance of Left-Green parties is collected from the municipal elections result. If the election result shows that the political governance in a municipality comprises of political parties from Left-Green parties, then this variable will take a value of 1 and 0 otherwise.

In Table 1 below, I present the descriptive statistics of the collected municipal level data from the year 2003 to 2016 and the following variables are: wind power capacity or effect (MW), number of installed wind power turbines, area, population density, wind speed and unemployment rate. Table 2 shows the frequency of coastal and mountainous areas, the Left-Green political parties as well as wind power installation. The political variable, wind speed, population density and the unemployment rate are time-lagged in five years to account for the time of investment it takes before the actual wind power installation. Choosing a time lag in five years may seem reasonable due to the fact that some of the permits can be in progress from six months up to ten years. The Swedish Windpower Association and electricity company *Vattenfall* are both consulted about this choice and based on their previous experience of wind power installments they agree in choosing 5 years.

Table 1. Descriptive Statistics

Variable	**Mean**	**Std. dev**	**Min**	**Max**	**No. of obs**
Wind turbines [a]	6	15	0	179	4 060
Effect [b]	17.72	32.52	0	341.4	1 985
Population density [c]	129	435	0	4 618	4 060
Area [d]	1 412.73	2 448.20	8.67	19 371.12	4 060
Unemployment rate [e]	5.70	2.36	0.92	17.35	4 054
Wind speed [f]	3.39	1.58	0.99	8.30	1 390

[a] It is the sum of the installed wind power turbines per municipality. (source: Swedish Energy Agency)

[b] It is the sum of the installed capacity (MW) of all wind power plants in a municipality. It is the theoretical standardized maximum capacity of a plant. (source: Swedish Energy Agency)

[c] It is the number of inhabitants per km^2 in a municipality. (source: Statistics Sweden)

[d] It is the size of land area of a municipality in km^2. (source: Statistics Sweden)

[e] It is the ratio of number of unemployed people and the population of people aged 15-64. (source: Swedish Public Employment Services)

[f] It is the average wind speed in m/s. (source: Swedish Meteorological and Hydrological Institute)

[10] See Table A2 and A3 in the Appendix for the list of coastal- and mountainous municipalities, respectively.

Table 2. Descriptive Statistics of binary variables

Variable \ Frequency	0	1
Wind power installation	2 092	1 968
	(51.53)	(48.47)
*Left-Green parties**	1 372	1 528
	(47.31)	(52.69)
Coastal areas	2 912	1 148
	(71.72)	(28.28)
Mountainous areas	3 850	210
	(94.83)	(5.17)

Note: Column percentage is reported in the parenthesis.
* The data for the election 1998 is not available and time-lagging this variable would, therefore, lead to 2,900 number of observations instead of 4,060 for complete data.

III.ii Model and Method

To analyze the expansion of wind power in Sweden, I estimate a Probit and a Tobit[11] model. The latter model is also called a *censored normal regression model*. The censored term refers to some observations on the dependent variable, which are censored, i.e. the dependent variable that is less than or equal to zero is not allowed to be observed. The Probit model is used to explain why there are installed wind power turbines in some municipalities but not in others. The Tobit model analyses which factors that are significantly related to the capacity of the wind power. Since the dependent variable installed wind power capacity contains several zero values, I use lower/left censoring.

These models are estimated with the Multiple-Imputation (MI) method to consider the missing values in the data where the missing values are disregardable or ignorable (StataCorp, 2013). For complete data, each variable should have 4,060 number of observations, but the data for installed capacity, unemployment rate and wind speed has 1985, 4054 and 1390 number of observations, respectively (see Table 1). In account of the

[11] Tobit models are essential to address the censoring, whereas OLS would be inconsistent and biased (Foster and Kalenkonski, 2013). The dependent variable installed capacity has a significant amount of zero-values that need to be censored. OLS regression does not account for these values and would thereby give inconsistent estimates of the parameters. That is, as the sample size increases, the obtained coefficients would not necessarily approach the ”true” population parameters (*Institute for Digital Research and Education*).

missing data and to obtained unbiased results, Multiple imputation method is therefore applied in this study.

Rubin's (1987) Multiple imputation method suits data sets with missing values. The definition of the *impute* in this approach is to "fill in". This method replaces each missing value with a set of plausible values, which depicts the uncertainty of the correct value to impute. The standard procedures for complete data are used to analyze these multiply imputed data sets. The results from these analyses are then combined and regardless of which complete-data analysis is used, the method of combining the results from different imputed data sets are basically identical. This produces conclusive statistical results that suitably reflect the uncertainty caused by missing values. On the other hand, the singular imputation method uses some other statistical method (e.g. mean value or median) to impute the missing values. Using these single values involves a level of uncertainty on which values to impute but with multiple imputations, several different "imputations" (or replications) decrease the level of uncertainty.

For the Logit/Probit model, the dependent variable is binary, which takes a value of either 1 or 0:

$$y = \begin{cases} 1 \; with \; probability \; p \\ 0 \; with \; probability \; (1-p) \end{cases} \tag{1}$$

The conditional probability takes the form

$$p_i \equiv \Pr(y_i = 1 \mid \mathrm{x}) = \mathrm{F}(x_i'\beta) \tag{2}$$

where $\mathrm{F}(x_i'\beta)$[12] is a described parametric function of $x_i'\beta$. The bounds $0 \leq p \leq 1$ are satisfied because $F(\cdot)$ is normally a cumulative distribution function for a continuous random variable. If the random error has a normal distribution then we have a Probit model, but if it has a logistic distribution instead, then we have a Logit model. A Panel-Probit regression is used to suit the panel data of this study. The choice between the Logit and Probit model may depend on the log-likelihood value although the difference is usually small (Cameron and Trivedi,

[12] β is a vector of unknown parameters while x is a *K X 1* regressor vector.

2009). In a nonlinear regression like Probit, measuring marginal effects is usually more informational than the coefficients. It is the change in the conditional mean of the outcome variable *y* when the explanatory variables *x* change by one unit (Cameron and Trivedi, 2005).

The dependent variable in the Tobit model is observed if the dependent variable is positive and not otherwise. Hence, the observed dependent variable is given by

$$y_i = \begin{cases} y_i^* = \beta x_i + u_i & if\ y_i^* > 0 \\ 0 & if\ y_i^* \leq 0 \end{cases} \tag{3}$$

In this case, the error term u_i has a so-called *truncated normal distribution* where the mean is nonzero. This is because the nonpositive dependent variables are omitted, as was mentioned above. Thus, the error term is unique for every observation and is dependent on the parameter β and independent variable x_i. For estimation, the maximum likelihood method is usually applied (Maddala, 2001). Instead of using the classical Tobit model in this study, I use the Multilevel Mixed-effects Tobit model to explain the absence of independence within municipalities and which also fits the panel-data (Stata, 2016).

In a panel-data, it is essential to control for time year-effects, which capture the effect of aggregate time trends (Dartmouth, 2018). With this, "year-dummies" are added in order to pick up any exogenous variation in the dependent variable that happens over time which is not attributed to the selected explanatory variables. A dummy variable representing the Left-Green political parties is added, which can take a value of either one or zero. A value of one implies that the majority of the political parties included in political governance are from the Left-Green parties, otherwise, it is zero. Dummy variables for the mountainous and coastal municipalities are also included.

In Table 3, the expected sign of each explanatory variable is listed based on the discussion in Section 2. Consequently, unemployment, coastal and mountainous areas, Left-Green political parties, fixed year-effects, wind speed and the size of a municipal area are expected to have a positive sign on wind power development. The population density is expected to give a negative effect instead. Accordingly, the hypothesized effects of these variables are either supported or refuted by the data. The local opposition protecting the landscape or residents who live nearby potential wind power farms might be reluctant to wind power due to e.g. noise and landscape intrusion. Thereby, if the project is to be located where the population increases, wind power projects may be hindered.

On the other hand, unemployment can support wind power expansion as a result of people's anticipation of job opportunities (Bergmann et al., 2006). This means that if the unemployment rate increases, the locals may support wind power investments. The location of wind power plants is normally where the wind blows sufficiently, therefore wind speed is assumed to give a positive effect as well. Furthermore, the adequate wind resource on coastal and mountainous areas makes wind power projects favorable in these areas. In line with this, if the project is to be located in these areas, it will be more likely to increase wind power investments and its capacity. Figure 1 shows that the amount of installed wind power turbines has increased between 2003 to 2016, therefore the year-effects can have a positive effect on wind power. The size of a municipal area is also expected to have a positive effect since larger areas can host more wind power. Lastly, the Left-Green political parties that have a relatively higher environmental ambition is assumed to influence the wind power capacity positively.

Table 3. Explanatory variables expected sign

Variable	**Expected effect on wind power capacity**
Area	Positive
Coastal area	Positive
Unemployment	Positive
Left-Green political parties	Positive
Mountainous area	Positive
Population density	Negative
Year-effects	Positive
Wind speed	Positive

Note: The variable number of turbines is excluded due to high correlation with the installed wind power capacity (see Table A4 in the Appendix).

Equations 4 and 5 below states the Probit and Tobit model[13] at the municipal level over the time period 2003 to 2016, where the explanatory variables are the following: unemployment, wind speed, population density, year-effects, Left-Green parties dummy[14], coastal and mountainous area dummies. The installed capacity, population density, unemployment and wind speed are in log-form to determine the percentage effect on the dependent variable of one percent change in a particular explanatory variable, ceteris paribus. Both of these models are inspired by the study of Ek et al. (2013). They use a Probit and a Truncated model to explain the location and installed capacity of wind power. They divided each model into two periods where the first one is during the slow growth and the second one is during the fast growth of wind power development. In their study, they consider the following variables: National Interest Area for Wind farm (NIAW), population density, land area, population trend, unemployment, experience (with earlier wind power) and environmental index.

Equation 4 specifies the potential variables that determine the deployment of wind power, in which physical factors such as wind speed as well as the quantity of wind resources in both coastal and mountainous areas initially play a big part in the deployment. Other important factors that can facilitate its actual implementation is the political stance of Left-Green parties and the economic incentives of wind power on employment. Nextly, equations 5 and 6 specify the potential determinants of wind power capacity. Consumers' employment status may have an impact on the potential capacity of wind power. This means that the socio-economic factor of unemployment may primarily influence the potential capacity.

Probit model

$$\begin{aligned}
&\Pr(Y = 1|X_i) \\
&= \Phi(\beta_0 + \beta_1 lnPopulationDensity_{t-5} + \beta_2 lnUnemployment_{t-5} + \beta_3 lnWindSpeed_{t-5} \\
&+ \beta_4 MountainousArea + \beta_5 CoastalArea + \beta_6 LeftGreenParties_{t-5} + \beta_7 YearEffects)
\end{aligned} \tag{4}$$

[13] The correlation between the number of turbines and wind power capacity as well as between the area and the mountainous area are both high and for a better model estimation wind power capacity and mountainous area are chosen (see Table A4 in the Appendix).

[14] These models cover the election results from 2002, 2006, 2010 and 2014.

Tobit model

$$lnEffect(MW) = \begin{cases} lnEffect(MW)^* & if \quad lnEffect(MW)^* > 0 \\ 0 & if \quad lnEffect(MW)^* \leq 0 \end{cases} \tag{5}$$

where

$$\begin{aligned} lnEffect(MW)^* \\ = \beta_0 + \beta_1 lnPopulationDensity_{t-5} + \beta_2 lnUnemployment_{t-5} + \beta_3 lnWindSpeed_{t-5} \\ + \beta_4 MountainousArea + \beta_5 CoastalArea + \beta_6 LeftGreenParties_{t-5} + \beta_7 YearEffects \end{aligned} \tag{6}$$

III.iii Diagnostic tests

The diagnostic tests are performed after the estimation of both models in order to test the consistency of the parameter estimators. According to Greene (2012), the degree of censoring in the Tobit model is the main factor of the presence of non-constant variance, which, if present will make the maximum likelihood estimators inconsistent. For the Probit model, Hosmer and Lemeshow's goodness-of-fit[15] test can be used to examine if the predicted and observed frequency closely matches each other. It means that, the closer they match, the better goodness-of-fit. However, with Multiple Imputation estimates, the post-estimation will be different e.g. testing subsets of coefficients equal to zero. In either case, the estimation of both models is done with robust standard errors.

Multiple imputation is one of the most common simulation-based methods in handling missing data in analysis (see Table 1 for the missing data). As mentioned above (Section *III.ii*), each missing value is replaced with a set of plausible values that would then decrease the level of uncertainty brought by these missing values. Accordingly, missing data implies a risk for eventual bias, which can be reduced by the number of replications (*M)* (Graham et al., 2007). This *M* is usually determined before the model specification and the number of replications should be large enough to support the robustness of the test (StataCorp, 2013).

[15] Likelihood-ratio test is reported automatically at the model estimation of Probit.

Also, the *M*[16] is dependent upon the amount of missing data (Graham et al., 2007), which, in this study, is equal to 20. After the model estimation, *mi test* command is used to perform a joint test of coefficients where the null hypothesis is that the coefficients on two or more variables are simultaneously equal to zero. This type of test is called the *test of the subsets of the coefficients* (StataCorp, 2013). In the analysis, the coefficients for unemployment, population density, Left-Green parties, wind speed, mountainous and coastal areas are tested. The result from this test shows that we can reject the null hypothesis and it is significant at 1% significance level (see Table A5 in the Appendix).

IV. Results and Discussion

Table 4 reports the results of both models. Note that Probit model determines which factors are related to wind power implementation in a municipality. Once the installation is done, the Tobit model analyses the factors that significantly influence the potential capacity of the installed wind power. Both Probit and Tobit models use the following variables: population density, unemployment rate, the Left-Green political parties and wind speed, which are all time-lagged in 5 years. Year-effects, as well as dummy variables for coastal and mountainous areas are also included. The variables' expected effect in both models is presented in Table 3 above. As discussed in Section 2, the electricity certificate has an impact on wind power investment but the analysis does not consider the effect of its price since it is identical among the municipalities. Since the gathered data ranges only from 2003 to 2016, the effect of this scheme on wind power prior to and after 2003 is not tested. The results from both models show that population density has a negative influence on the Swedish wind power while the coastal area has definitely a positive impact. However, the socio-economic factor of unemployment is not found to be significant in both models.

[16] Graham et al. (2017) and most of the litterature recommend *M*=20.

Table 4. Estimation results of the Probit and Tobit model

Regressor	Probit model	Tobit model
Unemployment	0.3754	-0.0424
	(0.8258)	(0.2096)
Population density	**-0.4758***	**-0.2817*****
	(0.2612)	(0.0494)
Left-Green parties	**-0.5930****	-0.0619
	(0.2670)	(0.1131)
Wind speed	**1.3243*****	-0.2804
	(0.3861)	(0.2112)
Mountainous area	**6.7733*****	-0.1849
	(1.6501)	(0.2742)
Coastal area	**4.9396*****	**0.4875*****
	(1.5919)	(0.1579)
Year [a]		
Constant	-	2.8684***
		(0.6887)
Number of observations	4,060	4,060

Note: *, ** and *** implies significance at the level of 10%, 5% and 1%, respectively
Heteroskedasticity Robust-standard errors in parentheses
[a] The year fixed-effects is reported in Table A6 in the Appendix.

IV.i Probit Model

The Probit model explains why there are wind power plants in some municipalities but not in others. Table 4 reports the marginal effects of this model, i.e. the effect on the probability that wind power will be installed when a particular regressor increases by one unit, holding all other regressors constant. The result shows that population density and the political stance of Left-Green parties are less likely to support wind power deployment in a municipality. The likelihood of installing wind power turbines in densely populated areas is small and this is due to some reasons such as the safety of the community as well as landscape and noise intrusion. The result also implies that the environmental ambition of the Left-Green parties may not have assisted wind power establishments at the municipal level. The possible reason for this might be some latent difference between the national and municipal support in wind energy development. This difference may lead to a conflict of aims that hinders wind power installment.

The wind speed, as well as the wind resource at the coastal and mountainous areas increase the probability of deploying wind power. This result confirms that physical wind resource is certainly one of the most important factors in the primary stage of locating wind power plants. Both mountainous and coastal areas increase the probability that a wind power project in a municipality will proceed, all else equal (relative to areas which are neither located by the coast nor by mountainous terrain). The natural wind resource in coastal and mountainous areas would be likely to result in wind power development. Toke et al. (2008) explain that wind power programs are dependent upon adequate wind resources in an area apart from prevailing institutional factors[17].

The year-dummies are all positive and significant between 2005 and 2016 compared to the reference year 2003, all else equal (see Table A6 in the Appendix). The observed increasing positive coefficients in the analysis between the years 2005 and 2014 imply that the Swedish municipalities are more likely to install wind power turbines during these years. This may confirm that the government's financial support for renewable electricity production has made a great contribution to wind power development.

IV.ii Tobit model

The result of the Tobit model analyzes the installed wind power capacity among Swedish municipalities. It shows that the population density significantly decreases the capacity of wind power, all else equal. From the result of the previous model, municipalities that are densely populated are less likely to install wind power turbines. Consequently, wind power capacity would also be negatively affected by an increase in the population. The result also shows that the rich wind resource from coastal areas continues to have a positive effect, which means that wind power capacity increases more compared to other areas, ceteris paribus. This finding explains that the natural wind resource in these areas may seem to

[17] The institutional factors in their study are namely- financial support mechanisms from the state, planning rules, landscape protection organisations as well as windfarms ownership patterns.

secure the production of electricity from wind power. As observed, the recorded highest level of installed capacity is located in the southern coastal part of Sweden (Malmö and Gotland). In addition, the year-dummies are all positive but are only significant during 2010 to 2016 compared to the reference year 2003, all else equal. These observed positive coefficients in the analysis increase between the year 2010 to 2016, which implies a positive trend in wind power capacity during these years.

V. Conclusion

Considering these findings, the Swedish wind power development at the local level has been primarily affected by the wind resource in coastal areas and the population density. From an investment point of view, wind speed is definitely of great importance for the installment of wind power turbines. Sufficient wind resource in coastal and mountainous areas increases the likelihood of wind power deployment. In contrast, the density of the population hinders the progress of the wind energy development. The possible reasons for this might be th community's safety as well as noise and landscape intrusion.

The environmental ambition of the Left-Green parties, which is expected to contribute to achieving the renewable energy target is however not supported. The current policy at the national level may not be fully implemented at the municipal level due to some uncertainties such as stable policy as well as legal provisions that control the evaluation of wind power's environmental impact and its planning process (Söderholm et al., 2007). With this, the permitting process and installation can be delayed or rejected. Further development of data and method are suggested for future studies about the Swedish wind power. Even though wind power contributes to a source of renewable energy, it is still of importance to make a cautious environmental assessment so as to ensure that the wind power industry can be environmentally sustainable.

References

Bergmann, A., Hanley, N. and Wright, R. 2006. Valuing the attributes of renewable energy investments. *Energy Policy*. 34(9): 1004–1014.

Cameron, T. and Trivedi, P. 2005. *Microeconometrics:methods and applications*. New York: N.Y. Cambridge University Press.

Cameron, T. and Trivedi, P. 2009. *Microeconometrics using Stata*. Texas, USA: College Station. Stata Press.

Dartmouth. 2018. *Always Control for Year Effects in Panel Regressions*. https://www.dartmouth.edu/~ethang/Lectures/Class17/Always%20Control%20for%20Year%20Effects%20in%20Panel%20Regressions.pdf

Ek, K., Persson, L., Johansson, M. and Waldo, Å. 2013. Location of Swedish wind power- Random or not? A quantitative analysis of differences in installed wind power capacity across Swedish municipalities. *Energy Policy*. 58: 135–141.

Ek and Persson 2014. Wind farms — Where and how to place them? A choice experiment approach to measure consumer preferences for characteristics of wind farm establishments in Sweden. *Ecological Economics*. 105: 193–203.

Ellis, G. and Ferraro, G. 2016. *The social acceptance of wind energy where we stand and the path ahead*. Luxembourg : Publications Office.

European Commission ; Directorate-General for Research 2003. *External costs : research results on socio-environmental damages due to electricity and transport*. Luxembourg: Publications Office. Available from: http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA20198:EN:HTML.

European Commision. 2014. *Support scheme*. European Union. https://ec.europa.eu/energy/en/topics/renewable-energy/support-schemes

Foster, G. and Kalenkoski, C., 2013. Tobit or OLS? An empirical evaluation under different diary window lengths. *Applied economics*. 45(20): 2994–3010.

Government Offices of Sweden. 2016. *Agreement on Swedish energy policy*. https://www.government.se/articles/2016/06/agreement-on-swedish-energy-policy/

Government Offices of Sweden. 2017. *Promoting wind power through new governmental support*. https://www.regeringen.se/pressmeddelanden/2017/12/nytt-stod-framjar-vindkraft/

Graham, J., Olchowski, W. and Gilreath, A., 2007. How Many Imputations are Really Needed? Some Practical Clarifications of Multiple Imputation Theory. *Prevention Science*. 8(3): 206–213.

Green, R. and Vasilakos, N. 2011. The long-term impact of wind power on electricity prices and generating capacity. *2011 IEEE Power and Energy Society General Meeting*. *IEEE*: 1–24.

Huijts, N.M.A., Molin, E.J.E. and Steg, L. 2012. Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews*. 16(1): 525–531.

IEA (International Energy Agency). 2014. *Policies and measures*. https://www.iea.org/policiesandmeasures/pams/sweden/name-21727-en.php

Institute for Digital Research and Education. *Tobit analysis*. https://stats.idre.ucla.edu/stata/dae/tobit-analysis/

IVA (Royal Swedish Academy of Engineering Sciences). 2016. *Electricity production i Sweden*. https://www.iva.se/globalassets/201604-iva-vagvalel-elproduktion-english-c.pdf

Liljenfeldt, J. 2017. Where the Wind Blows: the socio-political geography of wind power development in Finland, Norway and Sweden. *GERUM*. 2017:1

Maddala, G.S. 2001. *Introduction to econometrics*. 3. ed. New York ; Chichester: Wiley.

Manwell, J.F., McGowan, J.G., Rogers, A.L., Manwell, A.L. and McGowan, A.L. 2010. *Wind Energy Explained: Theory, Design and Application*. John Wiley & Sons, Ltd.

Michanek and Söderholm. 2006. *Medvind i uppförsbacke. En studie av den svenska vindkraftspolitiken*. Report to the expert group for environmental studies. Swedish Ministry of Finance, Stockholm.

Rubin, D.B., 1987. *Multiple imputation for nonresponse in surveys*, New York: Wiley.

Rygg, B.J. 2012. Wind power—An assault on local landscapes or an opportunity for modernization? *Energy policy*. 48: 167–175.

Stata. 2016. *Multilevel mixed-effects model*. https://www.stata.com/new-in-stata/panel-data-tobit-models/ https://www.stata.com/features/multilevel-mixed-effects-models/

StataCorp. 2013. *Stata Multiple-Imputation Reference Manual*. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP. https://www.stata.com/manuals13/mi.pdf

Sverigedemokraterna. 2011. *Sverigedemokratiskt Inriktningsprogram för Energipolitik*.

Sverigedemokraterna. 2013. *Inriktningsprogram Energi*. https://sd.se/wp-content/uploads/2013/08/inriktningsprogram_energi.pdf

Swedish Energy Agency. 2010. *16 kap. 4 § Miljöbalken– vad hände sen?*

https://www.vindlov.se/globalassets/nyheter/dokument/sammanstallning-16--kap-4---miljobalk.pdf

Swedish Energy Agency. 2015. *Vägledning om kommunal tillstyrkan vid tillståndsprövning av vindkraftverk*. https://www.energimyndigheten.se/globalassets/fornybart/framjande-av-vindkraft/vagledning-om-kommunal-tillstyrkan_2015-02-02.pdf

Swedish Energy Agency. 2016. *Produktionskostnader för vindkraft i Sverige*. https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=5592

Swedish Energy Agency. 2017. *The Swedish electricity certificate system*. http://www.energimyndigheten.se/en/sustainability/the-electricity-certificate-system/ https://www.energimyndigheten.se/globalassets/fornybart/elcertifikat/sv-norsk-marknad/illustration_gemensammarknad_eng.pdf

Swedish Energy Agency. 2018. *Planering och tillstånd*. http://www.energimyndigheten.se/fornybart/vindkraft/planering-och-tillstand/

Swedish Environmental Protection Agency. *Tillståndsprocessen vindkraft*. https://www.naturskyddsforeningen.se/sites/default/files/dokument-media/kampanjmaterial/Presentation_Vindkraft_Lansstyrelsen_Dalarna.pdf

Swedish Society for Nature Conservation. 2018. *Höjd ribba i miljöpolitiken: Granskning av riksdagspartiernas miljölöften inför valet 2018*. https://www.naturskyddsforeningen.se/sites/default/files/dokumentmedia/hojd_ribba_i_miljopolitiken_partienkat_2018.pdf

Swedish Wind Energy Association. *Vindkraft ger jobb*. https://svenskvindenergi.org/vindkraft-ger-jobb

Söderholm, P. and Pettersson, M. 2011. Offshore wind power policy and planning in Sweden. *Energy Policy*. 39(2): 518–525.

Söderholm, P., Ek, K. and Pettersson, M. 2007. Wind power development in Sweden: Global policies and local obstacles. *Renewable and Sustainable Energy Reviews*. 11(3): 365–400.

Toke, D., Breukers, S. and Wolsink, M. 2008. Wind power deployment outcomes: How can we account for the differences?. *Renewable and Sustainable Energy Reviews*. 12(4): 1129–1147.

Voogt, M., Boots, M. G., Schaeffer, G.J. and Martens, J.W. 2000. Renewable Electricity in a Liberalised Market – The Concept of Green Certificates. *Energy & Environment*. 11(1): 65–79.

Wizelius, T. 2015. *Vindkraft i teori och praktik*. 3.ed. . Lund: Studentlitteratur.

Wind Europe. 2018. *Trends and Statistics report*. https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Statistics-2018.pdf

WSP Analys och Strategi. 2012. *Rapport: Vindkraftens ekonomiska effekter 2010 -2020*. https://www.tuulivoimayhdistys.fi/filebank/198-taustaksi_vindkraftens_ekonomiska_effekter_final.pdf

Data source

Coastal municipalities. havet.nu.
https://www.havet.nu/?d=64

Land area in km^2. Statistics Sweden.
http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0802/Areal/table/tableViewLayout1/?rxid=cc1da346-333f-42f0-98aa-a7f89793170f
http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0802/Areal2012/table/tableViewLayout1/?rxid=cc1da346-333f-42f0-98aa-a7f89793170f

Mountainous municipalities. Swedish Environmental Protection Agency.
Bjärstig, T., Zachrisson, A., Svensson, J. and Thellbro, C. 2018. Grön översiktsplanering i fjäll- och fjällnära landskap. *Naturvårdsverket*. Rapport 6811.

Political party. Statistics Sweden.
http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__ME__ME0104__ME0104A/ME0104T1/table/tableViewLayout1/?rxid=e44025a9-858b-4cce-a0e1-fe66ba7fcaa4

Population density. Statistics Sweden.
http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__BE__BE0101__BE0101C/BefArealTathetKon/table/tableViewLayout1/

Unemployment. Swedish Public Employment Service.
https://www.arbetsformedlingen.se/Om-oss/Statistik-och-publikationer/Statistik/Tidigare-statistik.html

Wind power effect (MW) and number of turbines. Swedish Energy Agency.
http://www.energimyndigheten.se/fornybart/vindkraft/marknadsstatistik/ny-sida/vindkraftens-del-av-elforsorjningen-2015/

Wind speed (m/s). Swedish Meteorological and Hydrological Institute.
https://www.smhi.se/data/meteorologi/ladda-ner-meteorologiska-observationer#param=wind,stations=all

Appendix

Table A1. List of municipalities with installed wind power turbines

1. Ale
2. Alingsås
3. Aneby
4. Arjeplog
5. Askersund
6. Berg
7. Båstad
8. Bjurholm
9. Bjuv
10. Bollnäs
11. Borgholm
12. Bräcke
13. Dals-Ed
14. Degerfors
15. Dorotea
16. Enköping
17. Eslöv
18. Essunga
19. Falkenberg
20. Falköping
21. Falun
22. Färgelanda
23. Gislaved
24. Gnesta
25. Gnosjö
26. Gullspång
27. Gotland
28. Grästorp
29. Gällivare
30. Gävle
31. Göteborg
32. Götene
33. Håbo
34. Hallsberg
35. Halmstad
36. Hammarö
37. Haninge
38. Haparanda
39. Härnösand
40. Hässleholm
41. Hedemora
42. Helsingborg
43. Hjo
44. Hofors
45. Hudiksvall
46. Hultsfred
47. Hylte
48. Härjedalen
49. Höganäs
50. Höör
51. Hörby
52. Jokkmokk
53. Jönköping
54. Kalix
55. Kalmar
56. Karlsborg
57. Karlshamn
58. Karlskrona
59. Karlstad
60. Katrineholm
61. Kiruna
62. Klippan
63. Kramfors
64. Kristianstad
65. Kristinehamn
66. Krokom
67. Kumla
68. Kungälv
69. Kungsbacka
70. Kävlinge
71. Laholm
72. Landskrona
73. Laxå
74. Lekeberg
75. Leksand
76. Lidköping
77. Lilla Edet
78. Lindesberg
79. Linköping
80. Ljusdal
81. Ludvika
82. Lund
83. Lysekil
84. Malung-Sälen
85. Malå
86. Malmö
87. Mariestad
88. Mark
89. Markaryd
90. Mellerud
91. Mjölby
92. Mönsterås
93. Mora
94. Mörbylånga
95. Motala
96. Mullsjö
97. Munkedal
98. Nässjö
99. Nordanstig
100. Nordmaling
101. Norrköping
102. Norrtälje
103. Nybro
104. Ockelbo
105. Osby
106. Orsa
107. Orust
108. Pajala
109. Piteå
110. Ragunda
111. Rättvik
112. Robertsfors
113. Ronneby
114. Sala
115. Sandviken
116. Simrishamn
117. Sjöbo
118. Skara
119. Skellefteå
120. Skövde
121. Skurup
122. Smedjebacken
123. Sollefteå
124. Sorsele
125. Sotenäs
126. Staffanstorp
127. Stenungsund
128. Storuman
129. Strömstad
130. Strömsund
131. Sundsvall
132. Svalöv
133. Svedala
134. Säffle
135. Södertälje
136. Sölvesborg
137. Tanum
138. Tidaholm
139. Tjörn
140. Tomelilla
141. Töreboda
142. Torsås
143. Tranås
144. Trelleborg
145. Trollhättan
146. Trosa
147. Uddevalla
148. Ulricehamn
149. Umeå
150. Uppsala
151. Uppvidinge
152. Vadstena
153. Vaggeryd
154. Vänersborg
155. Vansbro
156. Vara
157. Varberg
158. Vårgårda
159. Värnamo
160. Västerås
161. Västervik
162. Vaxholm
163. Växjö
164. Vetlanda
165. Vilhelmina
166. Vindeln
167. Vingåker
168. Ystad
169. Årjäng
170. Åsele
171. Åstorp
172. Älvdalen
173. Älvkarleby
174. Ängelholm
175. Åmål
176. Åre
177. Öckerö
178. Ödeshög
179. Örebro
180. Örnsköldsvik
181. Österåker
182. Östra Göinge
183. Övertorneå

Table A2. List of mountainous municipalities

1. Arjeplog
2. Berg
3. Dorotea
4. Gällivare
5. Härjedalen
6. Jokkmokk
7. Kiruna
8. Krokom
9. Malung-Sälen
10. Sorsele
11. Storuman
12. Strömsund
13. Vilhelmina
14. Åre
15. Älvdalen

Table A3. List of coastal municipalities

1. Båstads
2. Borgholm
3. Bromölla
4. Burlöv
5. Danderyd
6. Falkenberg
7. Gävle
8. Göteborg
9. Gotland
10. Halmstad
11. Haninge
12. Haparanda
13. Härnösand
14. Helsingborg
15. Höganäs
16. Hudiksvall
17. Kalix
18. Kalmar
19. Karlshamn
20. Karlskrona
21. Kävlinge
22. Kramfors
23. Kristianstad
24. Kungälv
25. Kungsbacka
26. Laholm
27. Landskrona
28. Lidingö
29. Lomma
30. Luleå
31. Lysekil
32. Malmö
33. Mönsterås
34. Mörbylånga
35. Nacka
36. Nordanstig
37. Nordmaling
38. Norrköping
39. Norrtälje
40. Nyköping
41. Nynäshamn
42. Orust
43. Oskarshamn
44. Oxelösund
45. Piteå
46. Robertsfors
47. Ronneby
48. Simrishamn
49. Skellefteå
50. Skurup
51. Söderhamn
52. Söderköping
53. Södertälje
54. Sölvesborg
55. Sotenäs
56. Stenungsund
57. Stockholm
58. Strömstad
59. Sundsvall
60. Täby
61. Tanum
62. Tierp
63. Timrå
64. Tjörn
65. Torså
66. Trelleborg
67. Trosa
68. Tyresö
69. Uddevalla
70. Umeå
71. Valdemarsvik
72. Varberg
73. Värmdö
74. Västervik
75. Vaxholm
76. Vellinge
77. Ystad
78. Älvkarleby
79. Öckerö
80. Örnsköldsvik
81. Österåker
82. Östhammar

Table A4. Correlation matrix

	Wind Power	*Turbines*	*Effect (MW)*	*Unemployment*	*Wind speed*	*Left-Green parties*	*Population density*	*Area*	*Mountainous area*	*Coastal area*
Wind Power	1.0000									
Turbines	0.0294	1.0000								
Effect (MW)	0.0272	0.8705	1.0000							
Unemployment	-0.0288	0.0136	0.0985	1.0000						
Wind speed	0.0376	0.0401	-0.1205	-0.2462	1.0000					
Left-Green parties	-0.0330	-0.0052	0.0569	0.4677	-0.2138	1.0000				
Population density	0.0102	0.0813	0.1149	0.0140	-0.0155	0.1046	1.0000			
Area	0.0166	0.0151	0.0705	0.2063	-0.2521	0.3574	-0.1896	1.0000		
Mountainous area	0.0180	-0.0237	0.0420	0.1216	-0.1769	0.2706	-0.1373	0.8184	1.0000	
Coastal area	0.0377	0.0907	-0.0251	-0.0651	0.5544	-0.0570	0.2281	-0.3408	-0.4116	1.0000

Table A5. Joint test of coefficients

Probit model	**Tobit model**
(WindPower) Population density = 0	(Effect) Population density = 0
(WindPower) Unemployment = 0	(Effect) Unemployment = 0
(WindPower) Wind Speed = 0	(Effect) Wind Speed = 0
(WindPower) Left-Green parties = 0	(Effect) Left-Green parties = 0
(WindPower) Mountainous Area = 0	(Effect) Mountainous Area = 0
(WindPower) Coastal area = 0	(Effect) Coastal area = 0
F-value = 8.10***	F-value = 8.79***

*** denote significance at 1% level

Table A6. Time fixed-effects

Regressor	Probit model	Tobit model
Year		
2004	0.2110	0.0841
	(0.1334)	(0.1399)
2005	0.7535**	0.0413
	(0.3144)	(0.1467)
2006	1.0987***	0.0515
	(0.4145)	(0.1432)
2007	1.4016***	0.0894
	(0.4317)	(0.1443)
2008	1.9927***	0.1413
	(0.4806)	(0.1592)
2009	2.3478***	0.2263
	(0.4841)	(0.1693)
2010	2.7614***	0.3201**
	(0.5189)	(0.1589)
2011	3.2233***	0.4391***
	(0.6060)	(0.1669)
2012	3.7056***	0.5781***
	(0.7839)	(0.2047)
2013	3.9119***	0.6185***
	(0.8038)	(0.2217)
2014	4.1732***	0.6762***
	(0.6440)	(0.1706)
2015	4.0465***	0.7326***
	(0.6982)	(0.1675)
2016	3.8658***	0.7810***
	(0.7095)	(0.1708)

Note: *, ** and *** implies significance at the level of 10%, 5% and 1%, respectively
Heteroskedasticity Robust-standard errors in parentheses