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Evaluation of the Impact of Forest Certification on Environmental Outcomes in Sweden

Anna Nordén[1,2], Jessica Coria[1] and Laura Villalobos[1,3]

Abstract

Voluntary forest certification is an increasingly popular tool allowing producers who meet stringent environmental standards to label their products in the marketplace and potentially achieve greater market access and receive higher prices for their products. The voluntary nature of certification programs implies, however, that it is difficult to determine the effects of forest certification due to selection bias. This paper contributes to the impact evaluation of forest certification by estimating the effects of certification of non-industrial private forest owners in Sweden – one of the countries with the largest total area of certified forests. We rely on official forest inventory data at the plot level, information on certification status, and standard impact evaluation methods to identify the causal effect of certification on three environmental outcomes: environmentally important areas preserved during the felling, number of trees and high stumps left after the felling, and area set aside for conservation purposes. Moreover, we analyze the effect of the two most important certification schemes: the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). Our results indicate that certification has not improved any of these outcomes. Furthermore, we find no differences between the FSC and PEFC schemes. Our findings suggest that for forest certification to have an effect, the standards should be tightened and the monitoring and enforcement of forest certification schemes strengthened.

Keywords: certification, impact evaluation, sustainable forest management, treatment effects, Sweden, FSC, PEFC.
JEL Codes: L15, Q12, Q23, Q28.

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1. Introduction

Forests are among the most important repositories of terrestrial biological diversity. Together, tropical, temperate, and boreal forests offer highly diverse habitats for plants, animals, and microorganisms. Accelerated loss of old-growth forest (also termed primary or virgin forest) and intensive timber production have serious consequences for biodiversity conservation due to the loss of habitats (Angelstam et al., 2004; Folke et al., 2004).

Forest certification is a voluntary market-driven instrument whereby an independent third party (called a certifier or certification body) assesses the quality of forest management in relation to a set of predetermined standards. The certifier gives written assurance that a product or process conforms to the requirements specified in the standard (Rametsteiner and Simula, 2003). The general objective of forest certification is to provide information to the consumers about the quality of forest management in areas from which traded wood products are sourced. Producers who meet stringent environmental standards can then label their products in the marketplace, allowing them to potentially achieve greater market access and receive higher prices for their products. An environmentally sensitive consumer base should create incentives that reward certified producers, encouraging non-certified producers to seek certification and its market benefits. In this way, certification directs demand away from uncertified forests towards products that meet rigorous management criteria.

Forest certification has generated considerable attention as a mean to reverse deforestation and forest degradation by promoting improved environmental and social outcomes in forest management criteria (Auld et al., 2008). As a consequence, the global area of certified forest has been rapidly growing. For instance, the global area of certified forest increased from 18 million ha in 2000 to some 438 million ha in 2014. About 90 percent of the total area certified in 2014 is in the temperate and boreal climatic domains although there has also been growth, albeit at a slower pace, in the tropics and subtropics (FAO 2015).[i] The voluntary nature of forest certification implies, however, that environmental benefits from a certification scheme may be limited if only the producers who are already meeting environmental standards opt into certification. Hence, to properly assess the effectiveness of forest certification, we need to account for this selection problem. Unfortunately, due to the lack of suitable information, the evidence regarding the impact of forest certification on environmental outcomes using rigorous impact evaluation methods is very limited and finds mixed results. For example, the studies by Miteva et al. (2015) and Heilmayr and Lambin (2016) indicate that forest certification has reduced the rates of deforestation in Indonesia and Chile, respectively. In contrast, Blackman et al. (2015), Rico Staffron (2015), and Panlasigui (2015) find no evidence that forest certification has reduced deforestation in Mexico, Peru, and Cameroon, respectively.

The present paper contributes to the impact evaluation of forest certification by investigating the effects of the two main certification schemes (i.e., the Forest Stewardship Council, FSC, and the Programme for the Endorsement of Forest Certification, PEFC) in Sweden – the country with the largest total area of certified forest in Western Europe (i.e., 74% of its 28.2 million hectares of forest are certified; see UNECE/FAO, 2012). Unlike previous studies, which make use of remote sensing data sources, we use detailed forest inventory data at the plot level before and after the felling. This ground information is able to capture subtle changes in the amount and composition of the forest in small areas with higher precision than remote data sources, thus providing more precise estimates of the effects of forest certification. Furthermore, in contrast to previous studies analyzing the effects of forest certification on the rates of deforestation, we focus on the effects on avoided degradation. This is to say, we focus on the effects of forest certification on the avoided quality decrease in the forest with respect to the initial condition – an outcome measure whose assessment calls for observations on the ground and that relates directly to forest management practices and to the certification standards, thus enhancing the policy relevance of our study.

We investigate three key environmental outcomes on which certifications are expected to have an impact. First, we look at the effect of certification on the magnitude of the environmentally important areas preserved during the felling. The preservation of these areas is at the core of the standards' environmental principles and criteria. Second, we look at the number of trees and high stumps remaining in the plots 5–7 years after the felling. Because of the ecological value of these remainders, the certification standard encourages forest owners to leave both living wood and high stumps after clearing. Finally, we look at the certifications' requirement to set aside at least 5% of the total forest land for conservation purposes. Taking all of these environmental outcomes into consideration provides for a more complete assessment of the overall environmental impact of certification as it allows us to take into account the short and medium-term effects of forest certification.

In order to answer our research questions, we combine Swedish forestry inventory datasets with information on the certification status collected specifically for the purpose of this research. We use standard impact evaluation methods to identify the causal effect of certification on the outcomes. Importantly, the suitable harvesting form for the productive areas under analysis is clear cutting, which means that all trees are removed at once as opposed to selection cutting. As regrowth takes nearly 100 years, each plot is included only once in our sample. This eliminates the option of a panel data empirical approach.

Our results provide no evidence to support that certification improves environmental performance. Certified plots are not significantly more likely to preserve the environmentally important areas or to increase the magnitude of the areas that are saved. Furthermore, we find no effects on the number of trees and high stumps left in the plots 5–7 years after the felling or in the magnitude of the areas set aside for conservation purposes. Interestingly, we found no statistical differences between the environmental performance under the FSC and PEFC schemes. Our findings also point out that for forest certification to decrease forest degradation, the standards should be tightened and the monitoring and enforcement of forest certification schemes strengthened.

The paper is organized as follows. Section 2 briefly describes the forest sector and the certification schemes in Sweden. Section 3 presents the data and Section 4 the empirical strategy. Results are presented in Section 5. Finally, Section 6 discusses some policy implications and concludes the paper.

2. Background

Forestry is a key sector in Sweden. More than half of the country’s land area is productive forest, and forestry represents 11% of the total export income. There are several stakeholders in the sector, including around 330,000 private owners who own half of the productive forest. The other major category is private sector companies, with 25% of the productive forest (Swedish Forest Agency, 2014).

The Swedish Forestry Act states that environmentally important areas must not be damaged or destroyed during felling. In particular sensitive habitats, unusual trees and shrubs, and buffer zones have to be kept intact. Sensitive habitats are areas with high natural values deviating from the evenly aged production forest. Unusual trees and shrubs are those that have had time to develop some form of natural value, for example older, slow-growing, large or rare trees. Buffer zones and riparian zones are areas important for the conservation of species diversity in the forest floor, wetlands, lakes, and streams. The Swedish Forest Agency provides forest owners with detailed information about the definition of these categories, including for example illustrative pictures to facilitate their identification on the ground.[ii]

Two certification schemes operate in Sweden. The Forest Stewardship Council (FSC) certification was launched in 1998 when a working group comprising different forest stakeholders, including the NGO Swedish Society for Nature Conservation, introduced a national standard based on the international FSC guidelines. In contrast, the Programme for Endorsement of Forest Certification (PEFC) started in 2000 driven by private forest owner associations (see Johansson and Lidestav, 2011). FSC initially targeted large-scale forest companies while PEFC focused on small-scale private forest owners. However, at present, both standards certify any scale of operations from a minimum of 0.5 ha and are very similar in terms of requirements.

Currently, 50% of all productive forest land is certified under FSC and 48% under PEFC (FSC Sweden, 2014; PEFC Sweden, 2014). It is possible to hold both certifications simultaneously. Important for our research is that all major large-scale companies are FSC certified, making it difficult to identify the impact of certification on these contracts due to the lack of a control group. Therefore, our analysis focuses on non-industrial private forest owners, of whose land only around 17% is certified (Johansson and Lidstav 2011).

Adherence to forest certification is voluntary and the only eligibility requirement is to have productive forest with management purposes. However, the forest owners face transaction costs associated with the certification process. Information collected through a phone survey suggests that costs range between a one-time payment of around € 1,900 and an annual fee of € 210.[iii] Because the scale of operations is typically small for non-industrial private forest owners, they opt for group certificates to reduce transaction costs. It is through this scheme that timber suppliers for companies, associations, and larger private owners are certified. In all cases, the certification is valid for 5 years after which renewal is possible upon request.

Whereas FSC and PEFC Sweden set the standards, seven certifiers manage the certification in practice. These certifiers are authorized by accreditation organizations, named Accreditation Services International (ASI) for FSC and Swedish Board for Accreditation and Conformity Assessment (Swedac) for PEFC. The certifiers are responsible for monitoring compliance with the standard and are themselves inspected by the accreditation organizations. For the group certificates, the lead contract holders also monitor their respective members through annual spot checks.

The accreditation organizations, too, make random spot checks of certified forest every year to verify that the certification standards are followed. In case of violation, a Corrective Action Request (CAR) is issued, allowing for up to 12 months to remedy a small deviation and up to 3 months for a large one. After this, if the CAR is not attended to, the forest owner loses the certificate. Uncorrected or serious violations of a single member within a group certificate leads to its exclusion from the certificate. A report by WWF (Hirschberger, 2005) concluded that over the period 1997–2005, most CARs in Sweden concerned environmental issues, and most of the major transgressions concerned the failure to leave biodiversity trees and dead wood, as well as the lack of conservation of habitats and biotopes.

Timber prices vary greatly depending on for instance tree species, timber quality, infrastructure, and geographical location. Although precise statistics are hard to obtain, explorative figures suggest that certified timber has a price premium of up to 5% (see, e.g., Swedish Forest Agency 2014).[iv] Forest owners may also view certification as a way to establish a competitive advantage in the forest product marketplace. Certification may create opportunities to access new markets that favor certified forest products. For example, green building and publishing companies give preference to certified wood products and these markets are growing in popularity.

In Sweden, the requirements set by FCS and PEFC regarding the preservation of environmentally important areas within the plots to be cleared coincide with those established in the Swedish Forestry Act. Therefore, we should in principle not expect certification to produce any major impact on the conserved area beyond what is required by this law. However, the Swedish Forest Agency (2010) reports that around 30% of the inspected plots do not comply with the legal environmental consideration, i.e., sensitive habitats are not saved during the regeneration felling. Then, the first question we address in this paper is whether forest certification provides additional incentives to i) reduce the rate of non-compliance and ii) increase the share of environmentally important areas saved during regeneration felling.

FSC and PEFC certification standards also encourage forest owners to leave both living wood and high stumps after clearing, as such remainders have a high ecological value. The living wood becomes deadwood in the long run, and deadwood is one of the most important variables for measuring biodiversity in Sweden. Certification requests forest owners to leave a minimum of 10 trees per hectare and at least three high stumps per hectare. To evaluate the impact of the certification on this second component, we look at the number of trees and high stumps left in the plot 5–7 years after the felling.

Finally, FSC and PEFC certification standards require that a minimum of 5% of the owner's total forest area is set aside for conservation purposes. This area is independent of the plot to be cleared and has to be preserved entirely. We test whether this requisite is met and if there are differences in set-aside area between certified and uncertified plots.

3. Data

This section presents the data sources and sample size for each of the three environmental components of the standard under analysis. In each case, we describe in detail the outcomes, the definition of the treatment, and the control variables and present the corresponding descriptive statistics.

3.1 Environmentally important areas

In Sweden, all forest owners must submit a notification form to the Swedish Forest Agency before felling. On average, the agency receives 40,000 notifications from non-industrial private forest owners per year. From this pool, the agency selects a sample of plots for ground inspection.[v] During this unannounced field visit, inspectors conduct a forest inventory of the plot. One growing season (around one year) after the felling, the agency returns to the same plot and conducts another inventory in order to assess the new conditions. The information collected along this process is condensed in a dataset called Polytax 0/1, where 0 stands for the data collected before the felling and 1 stands for the data collected one year after. We base our analysis on the plots in Polytax 0/1 during the period 1999–2011 for non-industrial private forest owners under the category of regeneration felling. Our total sample includes 3,237 observations.

For the purpose of our analysis, a key variable missing in this dataset is whether the plot has adhered to a certification scheme. This missing information is what has prevented Polytax 0/1 from being used in previous analyses of the impacts of the certification program in Sweden. To collect such information, we conducted a phone survey where forest owners were asked about their certification status, date and type of certification, and other characteristics, such as participation in forest associations and reasons for being (and not being) certified (see Table A1 in the Appendix).

We successfully collected information for 1,450 plots (response rate 45%) through the phone survey.[vi] After removing forest owned by legal entities (e.g., Church of Sweden and forest belonging to municipalities), observations lacking information on certification status or year of certification, and outliers and missing values, we end up with a final sample of 1,171 observations, which we classify according to their certification status at the time of clearing. Table 1 lists all possible combinations and the corresponding number of observations.[vii]

Table 1: Polytax 0/1. Sample size by certification status before and after clearing, and treatment group classification

Group	Certification type and moment	# Observations	Treatment group
1	FSC before, no PEFC after clearing	53	T1 & T2
2	FSC before, PEFC after clearing	20	T1
3	PEFC before, no FSC after clearing	75	T1 & T3
4	PEFC before, FSC after clearing	17	T1
5	FSC & PEFC before clearing	82	T1 & T4
6	Doesn't know the cert type	226	-
7	FSC after, no PEFC after clearing	50	-
8	PEFC after, no FSC after clearing	68	-
9	Nothing before, both after clearing	64	-
10	No FSC no PEFC at any time	516	Control group
	Total	1,171	

For the core results, we defined four treatments and one control group. Treatment 1 (T1) is the most general and includes all plots with at least one certification at the moment of clearing, regardless of type and whether they add the other certification after felling (247 observations, groups 1–5 in Table 1). We also look at the effect of each standard independently by defining Treatments 2 and 3. Treatment 2 (T2) includes FSC certified plots at the moment of clearing that were not certified according to PEFC after felling (53 observations, group 1 in Table 1). Similarly, Treatment 3 (T3) includes plots that were PEFC certified at the moment of clearing, with no FSC after felling (75 observations, group 3 in Table 1). Finally, Treatment 4 (T4) contains plots holding both certifications at the moment of clearing (82 observations, group 5 in Table 1). The control group comprises plots not certified during the entire period of analysis (516 observations, group 10 in Table 1).

The Polytax 0/1 data includes precise measures of the environmentally important areas defined by the Swedish Forest Act and required by the certifications. We define the total environmentally important area as the sum of the areas under sensitive habitats, buffer zones, and unusual trees and shrubs. [viii] As these areas are measured both before and after clearing by the inventory, we can observe the magnitude of the reduction in the total environmentally important area for each plot.

From this measure, we define our outcome variables. Firstly, we classify the plots depending on their compliance status. A plot is in compliance if all of its environmentally important area was maintained during the felling. In contrast, a plot is not compliant if there is a reduction in the environmentally important area. Hence, the non-compliance rate is defined as a categorical variable taking the value 1 for any positive reduction in the relevant area and 0 if there is no change.

Secondly, we look at the magnitude of the damage in hectares, measured as the difference in total environmentally important area before and after clearing. We also look at the magnitude of the damage in relative terms, i.e., as a share of the total environmentally important area before clearing. This is important because there could be substantial variations in the magnitude of the environmentally important areas across plots (e.g., the opportunity costs of preserving environmentally important areas might vary with the size of the plot).

Our hypothesis is that if forest certification promotes a more sustainable management of the forest, both the compliance rate and the magnitude (in absolute and relative terms) of environmentally important area left after clearing should be larger (and positive) for certified forest owners. Table 2 reports descriptive statistics for the outcome variables. Note that the average plot size is 6.3 ha, of which less than one hectare is environmentally sensitive. This is not surprising as most of these areas are mainly productive forests. Furthermore, we observe that the average area of environmentally important areas decreases after clearing.

Interestingly, the share of the sample that does not comply with legal requirements is 65%, causing an average environmental damage of 0.2 ha (which represents 28% of the initial environmentally important area being cleared). This is not a negligible amount if we consider that the Forest Agency receives around 40,000 notifications of felling every year, which results in roughly 8,500 ha of environmentally important areas being cleared each year. Table 2 also shows that, on average, the non-compliers clear 40% of the initial forest area.

Importantly, the distribution of our dependent variable is positively skewed. The bulk of the data is at the left of the probability distribution, with 35% of the observations concentrated at the zero value and another 60% between zero and 1 hectare. For this reason we also define the log of the environmental damage as an outcome, as discussed in Section 4.

Table 2: Polytax 0/1. Descriptive statistics for the outcome variables

	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**
Area requested for felling (ha)	1,171	6.343	7.998	0.500	95.200
Environmentally important areas before clearing (ha)	1,171	0.659	1.492	0.000	21.915
Environmentally important areas after clearing (ha)	1,171	0.448	1.059	0.000	12.915
All sample					
Non-compliance rate	1,171	0.651	0.477	0.000	1.000
Environmental damage (ha)	1,171	0.211	1.040	0.000	21.915
Damage as share of the initial value	1,100	0.282	0.346	0.000	1.000
Conditional on positive environmentally important area before clearing					
Non-compliance rate	1,100	0.693	0.462	0.000	1.000
Environmental damage (ha)	1,100	0.225	1.071	0.000	21.915
Damage as share of the initial value	1,100	0.282	0.346	0.000	1.000
Conditional on positive environmentally important area before clearing and positive damage					

Non-compliance rate	762	1.000	0.000	1.000	1.000
Environmental damage (ha)	762	0.325	1.275	0.002	21.915
Damage as share of the initial value	762	0.407	0.350	0.000	1.000

The control variables included in our analysis are socioeconomic information about the owner (e.g., gender, whether the owner makes decisions about the forest management by him/herself, age, education, level of experience as a forest manager, i.e., low, medium, or high experience, whether the owner lives in or nearby the plot, and whether he/she belongs to a forest association).

We also include geographic control variables, such as size of the property, its location within Sweden (county), habitat index as a proxy for soil productivity (classified as low, average, and high), and density of forest roads in the municipality where the plot is located.

Table 3 presents the descriptive statistics for the control variables for the entire sample. Note that all variables are categorical (except for age, area requested for felling, and road density). As shown in the table, approximately 20% of the forest owners are females, 61% are single decision makers, and the average age is 60. More than two-thirds have 6–40 years of experience of managing the forest in question and 80% live in or nearby the plot. Furthermore, 68% of the plots have high soil productivity and 66% belong to a forest association. Finally, the average density of forest roads is 800 m/Km^2.

Table 3: Polytax 0/1. Descriptive statistics of covariates, entire sample

Variable	Obs.	Mean	Std. Dev.	Min	Max
Forest owner characteristics					
Female (dummy)	1,171	0.193	0.395	0.000	1.000
Single decision maker (dummy)	1,171	0.615	0.487	0.000	1.000
Age (years)	1,171	59.966	11.823	23.000	92.000
Education up to high school (dummy)	1,171	0.384	0.487	0.000	1.000
Up to 3 years of higher education (dummy)	1,171	0.162	0.369	0.000	1.000
Up to 4 years of higher education (dummy)	1,171	0.171	0.376	0.000	1.000
Other education (dummy)	1,171	0.039	0.194	0.000	1.000
Medium level of experience (6 to 40 years) (dummy)	1,171	0.771	0.420	0.000	1.000
High level of experience (more than 40 years) (dummy)	1,171	0.176	0.381	0.000	1.000
Owner lives in or nearby the forest plot (dummy)	1,171	0.806	0.395	0.000	1.000
Plot characteristics					

Area of the plot (ha)	1,171	6.343	7.998	0.500	95.200
High soil quality (dummy)	1,171	0.253	0.435	0.000	1.000
Medium soil quality (dummy)	1,171	0.685	0.465	0.000	1.000
Forest associations					
Södra (dummy)	1,171	0.295	0.456	0.000	1.000
Mellanskog (dummy)	1,171	0.168	0.374	0.000	1.000
Norrskog (dummy)	1,171	0.066	0.248	0.000	1.000
Norra (dummy)	1,171	0.091	0.288	0.000	1.000
Other (dummy)	1,171	0.036	0.186	0.000	1.000
None (dummy)	1,171	0.343	0.475	0.000	1.000
Municipality characteristics					
Road density (m/km^2)	1,171	803.623	323.397	59.695	1704.137

3.2 Trees and high stumps left

Our analysis is based on Polytax 5/7. This dataset is similar to Polytax 0/1 but includes a different sample of randomly chosen plots at which field visits and an inventory of the condition of the plot were made 5 or 7 years after the felling. Thus, in contrast to Polytax 0/1, Polytax 5/7 allows us to evaluate the effect of certification on the conditions of the plot in the medium term.

The sample comprises 2,769 observations. Through the phone survey, we successfully collected information for 1,240 plots (response rate 45%). After removing non-single-private forest owners, observations lacking information regarding certification status or felling year, and outliers and missing values, we end up with a final sample of 1,070 observations, which we classify in Table 4 according to their certification status at the time of clearing. Unfortunately, due to the limited number of observations within each category, we include in the treated group all plots ever certified, regardless of type or moment of certification (622 plots). This slightly modifies the interpretation of the results as we cannot control for the certification status at the moment of the clearing. In the control group, we include the 448 plots that were not certified during the period of analysis.

Table 4: Polytax 5/7. Sample size by certification status before and after clearing, and treatment group classification

Group	Certification type and moment	# Observations	Treatment group
1	FSC before, no PEFC after clearing	17	T1 & T2
2	FSC before, PEFC after clearing	19	T1 & T2
3	PEFC before, no FSC after clearing	19	T1 & T2
4	PEFC before, FSC after clearing	7	T1 & T2
5	FSC & PEFC before clearing	15	T1 & T2
6	Doesn't know the cert type	191	T2
7	FSC after, no PEFC after clearing	62	T2
8	PEFC after, no FSC after clearing	97	T2
9	Nothing before, both after clearing	119	T2
10	Year of certification unknown	76	T2
11	No FSC no PEFC at any time	448	Control group
	Total	1,070	

Our outcome variables correspond to the number of trees and high stumps left (per cleared hectare) and the corresponding probabilities of compliance. We report the descriptive statistics of our outcome variables in Table 5. On average, forest owners leave 8.7 trees and 1.49 high stumps per hectare, which is less than the numbers required by the certification (i.e., 10 trees and three high stumps). Also, the rate of non-compliance with the expected density of trees is 70% and 81% for the high stumps. These rates of non-compliance are by all means high but consistent with reports indicating that failure to leave biodiversity trees and dead wood is the most common transgression of certification standards (see Hirschberger 2005).

In terms of the covariates for this sample, we find very similar patterns as the ones described for the Polytax 0/1 database, which is not surprising as the sampling procedures for both databases are similar. For instance, 18% of the plots are owned by female forest owners and 65% by a single decision maker. The average age is about 60 years, 14% of the forest owners have up to three years of higher education, and 77% have 6–40 years of experience of managing their forest. Sixty-five percent of the forest owners belong to a forest association, and 82% live in or close to the forest plot. Finally, the road density in the municipalities is 795m/Km^2.

Table 5: Polytax 5/7. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Outcomes					
Number of trees left per hectare of cleared forest	1,065	8.729	11.337	0.000	115.34
Number of high stumps per hectare of cleared forest	1,065	1.492	2.363	0.000	19.11
Non-compliance rate (trees left)	1,065	0.697	0.460	0.000	1.000
Non-compliance rate (high stumps)	1,065	0.812	0.391	0.000	1.000
Covariates: Forest owner characteristics					
Area of the plot (ha)	1,070	6.777	8.856	0.500	94.20
Female (dummy)	1,070	0.178	0.382	0.000	1.000
Single decision maker (dummy)	1,070	0.639	0.480	0.000	1.000
Age (years)	1,070	60.010	11.934	22.00	91.00
Up to 3 years of higher education (dummy)	1,070	0.143	0.350	0.000	1.000
Medium level of experience (6–40 years) (dummy)	1,070	0.765	0.424	0.000	1.000
Forest owner belongs to a forest association (dummy)	1,070	0.645	0.479	0.000	1.000
Owner lives in or nearby the forest plot (dummy)	1,070	0.823	0.382	0.000	1.000
Covariates: Municipality characteristics					
Road density (m/Km2)	1,070	795.00	317.22	59.70	1704.14

3.3 Set-aside areas

The final database utilized in our study corresponds to the set-aside area survey conducted by the Swedish Forest Agency. In the survey, a random sample of small and medium-size forest owners is selected for a phone survey asking specifically about forest land voluntarily set aside for conservation purposes. Even if this data has been collected several times since 1996, we focus on the survey conducted 2009–2010 because it is the only survey that has included the certification status of the forest owner.

As mentioned above, the units of observation are small and medium-size forest owners (including social and local associations, as for instance, municipalities, foundations, religious communities, and economic associations). The survey includes information on the municipality in which the land is located, whether there are voluntary set-aside areas, the size of voluntary set-aside areas, whether the forest owner is certified, and, if so, number of years certified. We complemented this dataset with information from the Swedish Forest Agency on the total area that the forest owner owns within a municipality. With this information, we create an independent variable corresponding to the share of total land that is set aside voluntarily for conservation purposes. We then compare whether the average shares of set-aside areas differ between certified and non-certified forest owners.

Unfortunately, the data in this survey does not include sufficient information on other characteristics of the land or the forest owners for us to use as control variables. Fortunately, location allows us to control for some of the geographical variation, and size of the plot allows us to control for variations in the opportunity cost of setting aside areas for conservation purposes, as opportunity cost might vary with scale. Nonetheless, our results should be interpreted with caution, since the observed differences in the share of set-aside area could be explained by other characteristics omitted from this analysis due to lack of information.

The dataset includes 327 small and medium-size private forest owners who participated in the survey. We exclude forest owners with missing information or no set-aside areas and end up with 283 (86%) observations with valid information on the variables of interest. Of those, 95 observations do not hold a forest certification, 57 are certified by FSC, and 131 are certified by PEFC. Table 6 presents descriptive statistics for the relevant variables. We observe that on average, forest owners set aside 8.8% of their forested area for conservation purposes, which is higher than the 5% required by the standard. Moreover, approximately 60% of our sample set aside more than 5%, while 40% set aside less than required by the standard.

Table 6: Descriptive statistics set-aside areas

Variable	Obs.	Mean	Std. Dev.	Min	Max
Set-aside area (ha)	283	148.46	879.57	0.400	12588
Productive forest (ha)	283	11178	3433	7.000	38728
Set-aside area (%)	283	0.088	0.121	0.000	0.987
Set aside 5% or less (dummy)	113	0.028	0.015	0.000	0.050
Set aside more than 5% (dummy)	170	0.128	0.142	0.050	0.987
Certified (dummy)	283	0.664	0.473	0.000	1.000
Certified FSC (dummy)	152	0.375	0.486	0.000	1.000
Certified PEFC (dummy)	226	0.580	0.495	0.000	1.000

4. Empirical Strategy

As discussed before, our treatment is not a random variable since the certification program is voluntary. Indeed, forest owners self-select into the treatment. The challenge when trying to identify the causal effect of certification on the outcomes is that if there are systematic differences between the certified and the uncertified groups, we cannot attribute all the potential differences in the outcomes to certification status. Rather, the differences could be explained by other factors, commonly referred to as confounders.

Tables 7 and 8 present the normalized differences in covariates between the control and treated groups for the Polytax 1/0 and 5/7 datasets, respectively. For each characteristic, the normalized difference is defined as the difference in averages by treatment status, scaled by the square root of the sum of the variances (Imbens and Wooldridge, 2009). As a rule of thumb, values above 0.25 indicate that the difference between the groups is substantial and hence linear regression methods tend to be sensitive to the specification (Imbens and Rubin 2007). We also report the t-statistic for the difference in means as a reference.

In Panel A of Table 7, we observe that even when the groups are statistically different in many of the characteristics, the magnitude of the difference is substantial only for the covariates related to location of the plots and participation in forest associations. In particular, there are substantial differences in the quality of the soil and there is lower road density in the control group. From this analysis, we can conclude that because some of the covariates differ substantially between the treated and control groups, the conventional OLS analysis could be sensitive to specification and outliers (Imbens, 2015). Furthermore, we observe that most of the selection into the treatment is explained by the geographic location of the plots. Figure A3 in the Appendix shows the location of the certified and uncertified plots in Sweden.

Table 7: Means, t-test stat, and normalized difference in covariates between the control and treated groups. Before and after matching Polytax 0/1 dataset.

	Mean		T-Test Difference	Normalized Difference
	Certified	Non-Certified		
A. Before Matching				
Number of observations	516	247		
Female (dummy)	0.188	0.121	-2.432	-0.129
Single decision maker (dummy)	0.669	0.587	-2.147	-0.119
Age (years)	60.760	59.364	-1.622	-0.088
Education up to high school (dummy)	0.347	0.401	1.427	0.079
Up to 3 years of higher education (dummy)	0.157	0.158	0.033	0.002
Up to 4 years of higher education (dummy)	0.186	0.182	-0.129	-0.007
Other education (dummy)	0.045	0.020	-1.890	-0.097
Medium level of experience (6–40 years) (dummy)	0.756	0.789	1.044	0.057
High level of experience (more than 40 years) (dummy)	0.182	0.174	-0.273	-0.015
Owner lives in or nearby the forest plot (dummy)	0.798	0.838	1.342	0.072
Area of the plot (ha)	6.828	5.752	-1.855	-0.097
Medium soil quality (dummy)	0.341	0.158	-5.490	-0.292
High soil quality (dummy)	0.581	0.810	6.306	0.340
Forest associations (dummy)	0.477	0.830	8.928	0.491
Road density (m/km2)	6.439	6.779	8.162	0.446
B. After Matching				
Number of observations	102	193		
Female (dummy)	0.127	0.135	0.176	0.015
Single decision maker (dummy)	0.598	0.611	0.222	0.019
Age (years)	58.392	59.218	0.581	0.051
Education up to high school (dummy)	0.392	0.378	-0.232	-0.020
Up to 3 years of higher education (dummy)	0.098	0.155	1.446	0.121
Up to 4 years of higher education (dummy)	0.216	0.171	-0.908	-0.080
Other education (dummy)	0.039	0.026	-0.592	-0.053
Medium level of experience (6–40 years) (dummy)	0.716	0.777	1.135	0.099
High level of experience (more than 40 years) (dummy)	0.176	0.181	0.104	0.009
Owner lives in or nearby the forest plot (dummy)	0.853	0.839	-0.308	-0.026
Area of the plot (ha)	6.210	5.932	-0.280	-0.025
Medium soil quality (dummy)	0.216	0.192	-0.481	-0.042
High soil quality (dummy)	0.716	0.772	1.038	0.091
Forest associations (dummy)	0.657	0.793	2.408	0.212
Road density (m/km2)	6.608	6.712	1.828	0.161

Counties for which normalized difference > 0.25 before matching: 2, after matching: 0. Total number of counties: 21

Similar patterns can be seen for Polytax 5/7 (see Table 8), where the magnitude of the difference is substantial only for the covariates related to road density and the participation in forest associations.

Table 8: Means, t-test stat, and normalized difference in covariates between the control and treated groups. Before and after matching Polytax 5/7 dataset.

	Mean		T-Test Difference	Normalized Difference
	Certified	**Non-Certified**		
A. Before Matching				
Number of observations	448	622	.	.
Female (dummy)	0.190	0.169	-0.876	-0.039
Single decision maker (dummy)	0.690	0.603	-2.933	-0.128
Age (years)	60.018	60.005	-0.017	-0.001
Education up to high school (dummy)	0.444	0.434	-0.328	-0.014
Up to 3 years of higher education (dummy)	0.132	0.151	0.903	0.039
Up to 4 years of higher education (dummy)	0.145	0.175	1.333	0.058
Other education (dummy)	0.045	0.034	-0.894	-0.040
Medium level of experience (6–40 years) (dummy)	0.770	0.762	-0.306	-0.013
High level of experience (more than 40 years) (dummy)	0.158	0.203	1.860	0.081
Owner lives in or nearby the forest plot (dummy)	0.810	0.833	0.945	0.042
Area of the plot (ha)	7.359	6.358	-0.078	-1.752
Forest associations (dummy)	0.433	0.797	11.392	0.495
Road density (m/km2)	704.871	859.907	7.785	0.337
B. After Matching				
Number of observations	194	559	.	.
Female (dummy)	0.180	0.179	-0.047	-0.003
Single decision maker (dummy)	0.665	0.630	-0.888	-0.052
Age (years)	59.969	60.027	0.057	0.003
Education up to high school (dummy)	0.418	0.449	0.763	0.045
Up to 3 years of higher education (dummy)	0.124	0.145	0.757	0.044
Up to 4 years of higher education (dummy)	0.175	0.159	-0.510	-0.030
Other education (dummy)	0.041	0.029	-0.790	-0.048
Medium level of experience (6 to 40 years) (dummy)	0.804	0.780	-0.720	-0.042
High level of experience (more than 40 years) (dummy)	0.165	0.181	0.503	0.029
Owner lives in or nearby the forest plot (dummy)	0.835	0.828	-0.218	-0.013
Area of the plot (ha)	7.300	6.313	-1.253	-0.078
Forest associations (dummy)	0.593	0.775	4.513	0.271
Road density (m/km2)	745.670	843.906	3.602	0.211

Counties for which normalized difference > 0.25 before matching: 0; after matching: 0. Total number of counties: 21

To account for the potential selection bias, we first fit an OLS regression in which we control for observed heterogeneity by including the covariates:

$$Y_{ijt} = \beta_1\, Treatment_i + \sum_{l=1}^{L} \boldsymbol{\alpha_l Z_{il}} + \sum_{m=1}^{M} \boldsymbol{\delta_m X_{im}} + \gamma_j + \eta_t + u_{ijt},$$

where Y is the outcome for the i-th plot located in the j-th county felled at time t. For the analysis of the environmentally important areas, we test different definitions for the outcome: the cleared area (measured in absolute and relative terms) and the non-compliance rate. As the cleared area follows a log-normal distribution, we also use the log as outcome. Note that by defining the cleared area in logs, we consider only plots with a positive amount of cleared area. Similarly, the cleared area in relative terms includes only those plots with a positive initial value of environmentally important areas. For the analysis of the number of trees and high stumps left after felling, we define the dependent variable in relative (i.e., number of trees/stumps per hectare) and discrete terms (i.e., non-compliance rate).

Both in the case of the analysis of environmentally important areas and in the case of the number of trees and high stumps left, the coefficient of interest is β_1, which measures impact of certification on the outcome. $Treatment$ is a dummy variable taking the value 1 if the plot is certified and otherwise 0 according to the previously defined treatment groups. $\boldsymbol{Z}$ is a vector of L forest owner characteristics, and $\boldsymbol{X}$ is a vector of M plot characteristics. γ_j are county fixed effects, η_t are felling year fixed effects, and u_{ijt} is the error term. We also estimate the average treatment effect on the treated (ATT) with OLS following Wooldridge (2010). This estimator finds the average treatment effect for the certified plots and is useful for comparing the results with the matching estimator.[ix]

Before we proceed with the matching method, we make use of the propensity score matching method to obtain a more balanced sample. This will ensure that the results are more robust with any estimator (see, e.g., Rosenbaum and Rubin, 1983; Imbens, 2015). We trim the sample based on the propensity score matching without replacement using one neighbor and a caliper of 0.01. We choose this caliper value to select the observations that are closest in terms of propensity score in order to reduce the selection bias (Caliendo and Kopeinig, 2008).

The characteristics we consider for the matching are those explaining the profitability of the certification, the intrinsic motivations for conservation, and the access to information. The relevance of these characteristics as determinants of certification status was revealed by the forest owners in our survey (see main motivation behind certification and non-certification in Table A2 in the Appendix). For example, participation in forest associations reduces transaction cost and up-front payment to become certified, and hence it is expected to play an important role in the probability that a forest owners gets certified.

Environmental awareness could also affect the certification status. As proxies for environmental awareness we include level of education and other demographic variables such as gender, age, experience, and how involved the forest owner is in the forest management (measured by whether he/she lives close to the plot and by whether he/she makes decisions on his/her own as opposed to with peers). As determinants of the profitability of the certification we include the characteristics of the plot and its location. More exactly, we include total area of the plot, soil quality, and density of roads to account for these geographic differences. For the regression adjustment, we include county and year dummy variables in addition to the set of covariates we used for the matching.

We use covariate matching (CVM) after trimming the sample to estimate the average treatment on the treated (ATT) based on the propensity score (Imbens, 2015). For the CVM we consider one neighbor, and observations are matched using the Mahalanobis distance defined by covariates. The matching is with replacement and after matching all treated units the remaining bias is removed by a regression on the covariates (Abadie and Imbens, 2012).

One advantage of the matching is that the results are less sensitive to the specification of the functional form (see, e.g., Imbens, 2015). With matching, we construct a control group that mimics the treated group in all relevant observable characteristics. This matched control group is intended to resemble the counterfactual, i.e., what would have happened had the treated group not received the certification.

Matching as a strategy to control for covariates is motivated by the assumption that conditional on observed characteristics, the potential outcomes are independent of the treatment assignment and that there is sufficient overlap in the characteristics of the groups so that a sufficiently similar counterfactual can be constructed from the data (Angrist and Pischke, 2008). We verify the plausibility of these assumptions in the Appendix.

5. Results

In this section we report the results of our analysis for each of the three environmental outcomes under evaluation. We start by presenting the effects of the certification on the environmentally important areas. For this first component, we first describe the effects of certification for the whole sample and then by certification status. Next, we present the results for the number of trees and high stumps. We close by presenting the analysis of the set-aside areas and running robustness checks to control for potential selectivity bias.

5.1 Forest Certification and Conservation of Environmentally Important Areas

Tables 9 and 10 present the main results for the environmentally important areas. In Table 9 we address the question: Does forest certification affect the probability and magnitude of compliance with preservation of environmentally important areas during the felling? In columns we compare the results obtained with different estimation strategies, and in rows we specify different definitions for the outcome.

In the first column of Table 9, we show the difference in means between the treatment and the control. We observe that certified plots have a 3.7% lower probability of non-compliance compared with non-certified plots, but this difference is not statistically significant. Also, a smaller environmentally important area is cleared on certified plots. This difference is statistically significant when we define the dependent variable in logs, probably as a result of a better adjustment of the model.

In the second column of Table 9, we add county and year fixed effects to account for the spatial and temporal variability. The results show that once we take the regional differences into account, there is no effect of the certification on the probability or magnitude of non-compliance.

This result holds when we add additional observed characteristics that could confound the effect. We find similar effects when computing the average treatment effect on the treated (ATT) in column 4, which estimates the effect of certification for the certified plots.

We present the results for the covariate matching (CVM) in the last column and find that the zero effect holds even when comparing the treated group with a comparable non-certified group. These estimates are comparable with the ATT with OLS (column 4), but the sample size is smaller since only matched observations are included. We note that the magnitude of the coefficients is fairly stable across estimation methods once we control for possible confounders, but the effect is not statistically different from zero in any case.

Table 9: Effects of a forest certification on environmentally important areas. Different model specifications in columns and different outcome specifications in rows

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Dependent variable	**Difference in means**	**OLS (year and county FE)**	**OLS (all covariates)**	**ATT with OLS (all covariates)**	**ATT with CVM on trimmed sample**
Treatment 1: Any certification at the time of clearing=1, never certified=0					
Non-compliance rate	-0.037	0.013	0.010	0.012	0.034
Standard error	[0.037]	[0.042]	[0.045]	[0.052]	[0.084]
Observations	763	763	763	763	295
R-squared	0.001	0.134	0.161	0.210	
Area cleared (ha)	-0.057	0.043	0.038	0.059	0.076
Standard error	[0.069]	[0.093]	[0.086]	[0.059]	[0.101]
Observations	763	763	763	763	295
R-squared	0.001	0.029	0.091	0.157	
Area cleared (log)	-0.430**	-0.052	-0.121	-0.289	-0.037
Standard error	[0.185]	[0.221]	[0.233]	[0.287]	[0.427]
Observations	495	495	495	495	186
R-squared	0.011	0.093	0.184	0.275	
Area cleared (%)	-0.011	0.019	0.023	0.031	0.024
Standard error	[0.028]	[0.033]	[0.035]	[0.037]	[0.060]
Observations	715	715	715	715	273
R-squared	0.000	0.067	0.085	0.163	

[1] For simplicity we present the linear probability model (OLS), but the results also hold with non-linear probability models (Probit). All covariates include all variables listed in Table 3 and county and year fixed effects. Variables used for the matching: all variables listed in Table 3. Bias adjustment in CVM includes all covariates. Covariate matching includes one neighbor and estimates the average treatment effect on the treated. The sample includes 21 counties and 13 years cleared (%) is the change in the environmentally important areas divided by the initial value. Reported standard errors are Robust (White, 1980) for OLS, and Abadie and Imbens (2006, 2012) robust standard errors for covariate matching. ATT: average treatment on the treated. CVM: covariate matching. FE: fixed effects. OLS: ordinary least squares. *** p<0.01, ** p<0.05, * p<0.1

In Table 10, we look at the effects of each certification standard separately and test whether there are any differences between them. We also test whether holding both certifications simultaneously has an effect on the outcomes. We compare the treatment effects obtained by OLS including all covariates. We find the same results: there is no evidence that FSC or PEFC certification plots decrease the probability or the magnitude of non-compliance. Also, we observe no difference between the labels.

Table 10: Effects of certification on environmentally important areas by certification label

	(1)	**(2)**	**(3)**	**(4)**
Dependent variable	**FSC=1, Uncertified=0**	**PEFC=1, Uncertified=0**	**Both FSC and PEFC=1, uncertified=0**	**FSC=1, PEFC=0**
Non-compliance rate	0.055	-0.026	0.015	0.073
Standard error	[0.070]	[0.059]	[0.075]	[0.115]
Observations	569	591	598	128
R-squared	0.149	0.178	0.154	0.501
Area cleared (ha)	0.193	0.007	0.058	0.316
Standard error	[0.264]	[0.057]	[0.073]	[0.265]
Observations	569	591	598	128
R-squared	0.097	0.089	0.088	0.519
Area cleared (log)	0.194	0.063	-0.041	-0.013
Standard error	[0.386]	[0.330]	[0.385]	[0.606]
Observations	381	383	390	82
R-squared	0.202	0.175	0.188	0.586
Area cleared (%)	0.063	0.042	0.003	-0.025
Standard error	[0.058]	[0.051]	[0.052]	[0.085]
Observations	538	551	560	119
R-squared	0.113	0.106	0.096	0.529

All models are OLS including all covariates.

Thus, our analysis shows no evidence to support the hypothesis that forest certification increases the preservation of the environmentally important areas during felling. Furthermore, we find no difference between certification labels. This might not be a surprising result since the competition between FSC and PEFC has caused the certification standards to become increasingly similar, and as described in Section 2, the requirements of both FSC and PEFC coincide with those established by the Swedish Forestry Act. It raises however questions regarding the value-added of multiple certifications and label competition on overall environmental protection.

5.2 Forest Certification and the Number of Trees and High Stumps Left

To analyze the effects of forest certification on the number of trees and high stumps left, we conduct a similar analysis as in the previous section. We present the results in Table 11. In columns we present either number of trees or high stumps left per hectare and compliance rates. In rows, we present the results for OLS and CVM by treatment. We find no robust evidence that certification has a significant effect on the number of trees or high stumps left.

Table 11: Effects of certification on environmental outcomes 5–7 years after clearing

	(1)	(2)	(3)	(4)
	Trees left/ha		High stumps left/ha	
	Number	Non-Compliance Rate	Number	Non-Compliance Rate
Certified at any time				
OLS	0.888	-0.056*	0.106	-0.000
Standard Error	[0.894]	[0.033]	[0.156]	[0.027]
Observations	1,065	1,065	1,065	1,065
R-squared	0.161	0.125	0.169	0.136
Covariate Matching	-1.877	-0.012	-0.270	0.032
Standard Error	[1.624]	[0.054]	[0.322]	[0.046]
Observations	749	749	749	749

All covariates and counties and year fixed effects included. Robust standard errors for OLS, and Abadie and Imbens (2006, 2012) standard errors for covariate matching in brackets. *** p<0.01, ** p<0.05, * p<0.1.

5.3 Forest Certification and Set-Aside Areas

Finally, our results show that, on average, certified owners set aside 8.8% of the land. This share is higher than the 5% required by the certification schemes, but is not statistically different to the 7.3% left by non-certified forest owners (see Table 12). Furthermore, we explore whether there are differences between certification types. FSC-certified forest owners set aside 0.9% more area than non-certified forest owners; the corresponding figure for PEFC-certified forest owners is 2.8%. These differences are, however, not statistically significant at conventional levels, even when we control for geographic location by including the forest area and county fixed effects.

We are cautious in drawing conclusions from these results since, as mentioned there could be confounders that are not included in the analysis. Nevertheless, in line with the results presented in the previous sections, our analysis points to a lack of incremental effect of forest certification on the size of the areas set aside for conservation purposes.

Table 12: Effects of certification on share of set-aside areas

Variable	(1) Any certification	(2) Only FSC	(3) Only PEFC	(4) Any certification	(5) Only FSC	(6) Only PEFC
Certified (dummy=1 if yes)	0.0224	0.0096	0.0280	0.0203	0.0112	0.0272
	[0.015]	[0.016]	[0.018]	[0.017]	[0.019]	[0.020]
Area of productive forest (thousand ha)				0.0047**	0.0023	0.0059**
				[0.002]	[0.002]	[0.003]
Constant	0.0731***	0.0731***	0.0731***	0.0406	0.0491	0.0789
	[0.012]	[0.010]	[0.014]	[0.043]	[0.043]	[0.055]
Control variables included	NO	NO	NO	YES	YES	YES
Observations	283	152	226	283	152	226
R-squared	0.008	0.002	0.011	0.061	0.100	0.085

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Control variables include county fixed effects.

5.4 Robustness Checks and Potential Selectivity Bias

Finally, we test whether selection bias affects our results as roughly half of the sample did not complete the survey through which we obtained the forest owners' certification status. To this end, we test whether there are systematic differences in the observable characteristics between the samples. We present the results in Table A1 in the Appendix. We have older forest owners, fewer women, and some regional differences in the surveyed sample. To account for this potential sample selection bias, we use the two-stage Heckman model (Heckman, 1979) both for Polytax 0/1 and Polytax 5/7. Thus, we first use the entire sample of forest owners to estimate the probability that the survey is completed. The dependent variable takes the value of 1 if the survey was completed and zero otherwise. As explanatory variables, we include demographic variables that could explain the response rate and that are available for the entire sample, i.e., gender, age, and owner present. These variables are assumed to affect the probability of answering the survey, and the previous analysis showed that they are not key determinants of the quality of the forest management. In the second stage, we correct for selectivity bias by including the inverse Mills ratio obtained from the first stage in the deforestation equation, all control variables related to the geographic characteristics, participation in forest association, education, experience as forest owner, and county and year fixed effects. In both cases, the Heckman selection model finds an effect of the certification almost identical to the OLS with all covariates (Column 3 in Table 9, and Columns 2 and 4 in Table 11). Furthermore, in all cases the lambda parameter is not significantly different from zero, which suggests that unobserved factors that make participation in the survey more likely are not associated with forest management.

6. Conclusions

In this paper we investigate the effects of the two main forest certification schemes in Sweden, FSC and PEFC, on three key environmental outcomes embedded in the certification standards, namely environmentally important areas preserved during felling, number of trees and high stumps left after felling, and area set aside for conservation purposes. Our main result is that with regard to the performance of comparable non-certified forest owners, certification has not led to any additional improvements in these outcomes. Moreover, certified forest owners are not significantly more likely than similar non-certified forest owners to comply with certification standards. Furthermore, there is no difference between the certification schemes, which is not surprising given the similarity of the standards. In contrast, the geographic location of the plots, soil productivity, and participation in forest associations seem to be key factors explaining compliance with certification standards and the selection into treatment.

Our results are robust to the model choice; OLS and propensity score matching yield similar qualitative results. This is not surprising given that the treated and control groups are quite similar in many of the characteristics to start with. Also, the results are robust to various alternative definitions of the treatment and outcome variables.

Our results contribute to the evidence that forest certification is generally not associated with increased environmental benefits (see e.g., Blackman et al. 2015, Rico Staffron 2015, and Panlasigui 2015). Nevertheless, in contrast to previous studies that have focused on deforestation, our study provides evidence of the lack of effect of certification on avoided degradation vis-à-vis the performance of comparable non-certified forest owners. Furthermore, while previous studies have analyzed the effects of certification in the context of developing countries, we focus on the case of Sweden, a developed country with the largest total area of certified forest in Western Europe. We acknowledge that national forest certification standards are the result of voluntary negotiations among stakeholders with different goals and power, and hence, are thus context-dependent because countries and regions have different forest–industrial regimes. Nevertheless, the fact that empirical evidence has shown that the effects on certification are limited both in the context of developing and developed countries raises concerns about the role of forest certification as a tool to promote sustainable forest management practices. Our results seem to indicate that if forest certification in Sweden is to have an effect, it needs to become more stringent, not only when it comes to the standards but also in terms of monitoring and enforcement since neither certified nor non-certified owners are in compliance with the environmental outcomes and certification standards studied in this paper. Indeed, though the identification of the causal factors that might explain our results goes beyond the scope of our analysis, we believe that the high rates of non-compliance might be the result of the lack of clear definitions and quantifiable measures regarding what constitute sustainable forest management in the Swedish Forestry Act. Even though the Swedish Forest Act states that preservation of natural and environmental values should be prioritized to the same extent as forest production values, the lack of clear quantifiable measures makes it difficult for the certifiers to implement standards that are stringent enough and legitimized by society.

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APPENDIX

Table A1. T-tests for the difference in observed characteristics between phone survey respondents and non-respondents.

	Responded	Not responded	Difference
Non-compliance rate	0.647	0.638	0.009
Female (dummy)	0.229	0.253	-0.026*
Age (years)	60.282	58.554	1.764***
Owner lives in or closeby the forest plot (dummy)	0.793	0.765	0.036**
Medium soil quality (dummy)	0.261	0.301	-0.038**
High soil quality (dummy)	0.674	0.624	0.047***
Stockholms County	0.024	0.033	-0.008
Uppsala County	0.021	0.021	-0.002
Södermanlands County	0.036	0.037	-0.001
Östergötlands County	0.033	0.042	-0.008
Jönköpings County	0.038	0.033	0.006
Kronobergs County	0.050	0.040	0.009
Kalmar County	0.075	0.069	0.004
Gotlands County	0.037	0.024	0.012*
Blekinge County	0.049	0.037	0.013*
Skåne County	0.045	0.036	0.008
Hallands County	0.052	0.033	0.017**
Västra Götalands County	0.083	0.072	0.012
Värmlands County	0.050	0.059	-0.012
Örebro County	0.041	0.044	-0.001
Västmanlands County	0.025	0.030	-0.006
Dalarnas County	0.041	0.042	-0.004
Gävleborgs County	0.039	0.035	0.004
Västernorrlands County	0.035	0.051	-0.016**
Jämtlands County	0.060	0.061	-0.004
Västerbottens County	0.073	0.102	-0.017*

Figure A1: Location of certified (green circle) and uncertified plots (red diamond) within Sweden. Treatment 1 versus control group, Polytax 0/1

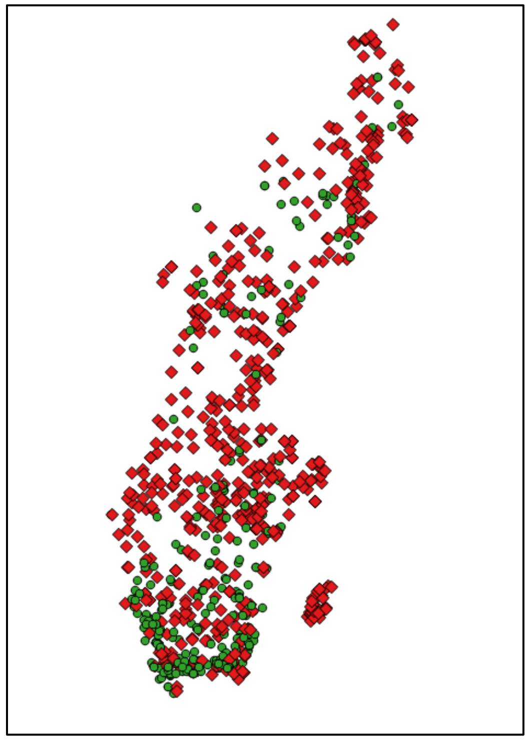


Table A2: Main motivation behind (non)certification:

What is your main reason for not choosing to certify your forest? (mark only one option)	Freq	Percent	Cum
1: No, or not enough, information about certification	101	20	20
2: Too expensive, not economically viable	39	8	27
3: Demands too tough, cannot live up to them, do not want to create lock-in effects	25	5	32
4: Not good for the environment, does not lead to sustainable forestry	7	1	33
5: Do not know anyone who is certified	7	1	35
6: Too small acreage	68	13	48
7: Other	207	40	88
8: Do not know	60	12	100
Total	514	100	
What was your main reason for becoming certified? (mark only one option)			
1: Good PR	19	3	3
2: Economically viable	293	45	48
3: Reasonable demands that are possible to fulfill	24	4	51
4: Good for the environment, leads to more sustainable forestry	153	23	75
5: Know someone / some certified	10	2	76
6: Other	119	18	95
7: Do not know	36	6	100
Total	654	100	

Robustness checks

In this Section we perform several robustness checks to evaluate the quality of the matching.

Overlap assumption

We report the normalized difference in the covariates after matching on the propensity score in Panel B of Table 8 for the Polytax 0/1 analysis, and in Panel B of Table 9 for Polytax 5/7. We observe that after matching, the normalized differences decrease substantially and the normalized differences for all covariates are lower than or very close to the 0.25 threshold. As a result, we obtain a sample that has a better overlap in all covariates. By matching on the propensity score, we drop 54 (22%) and 86 (16%) observations from the treated group of Polytax 0/1 and Polytax 5/7, respectively, because they have no counterparts in the control group. We present this information graphically in Figures 1 and 2. We observe that the treated observations off-support have high propensity scores. There is good overlap between the treated and the control groups everywhere else in the distribution.

Figure A2: Histogram of the propensity score by treatment status for Polytax 0/1

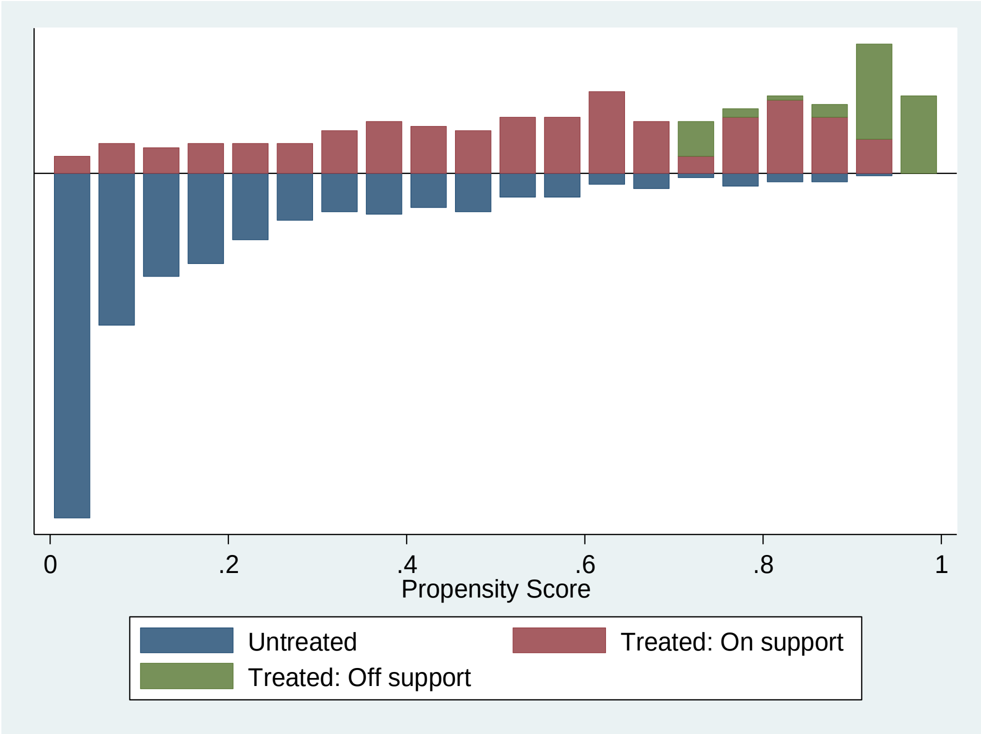
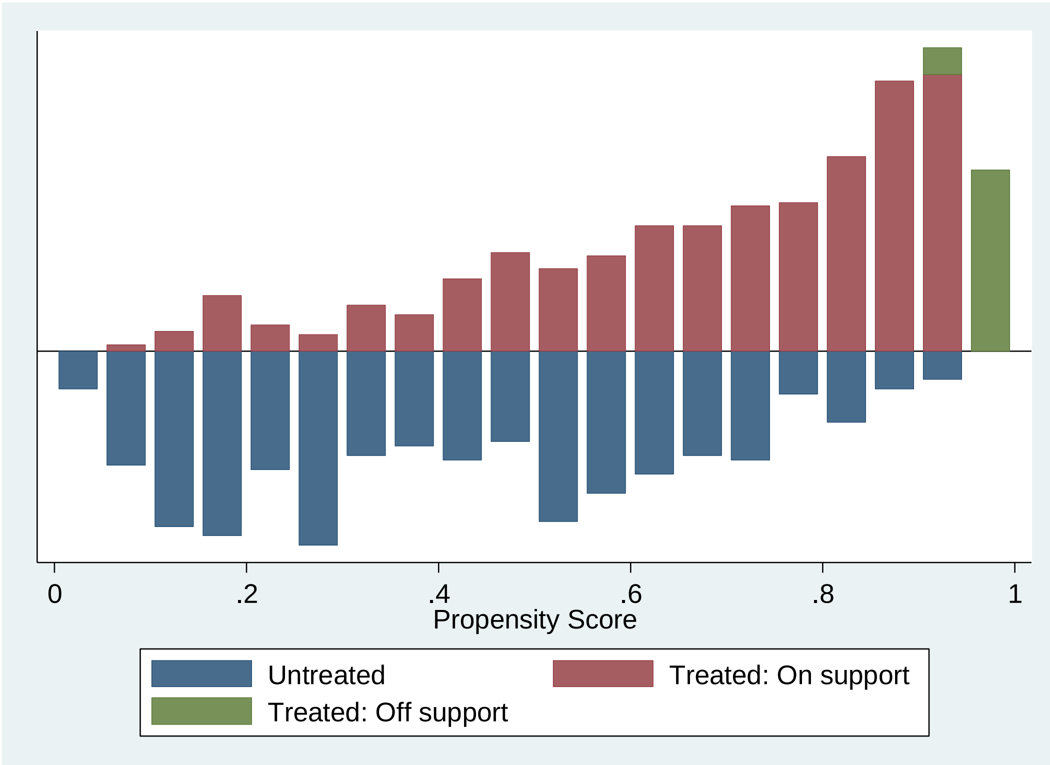


Figure A3: Histogram of the propensity score by treatment status for Polytax 5/7



Unconfoundedness

Following the test proposed by Imbens (2015), we perform an analysis of the plausibility that our matching method meets the unconfoundedness assumption. We test whether the method results in a sample that is as good as random conditional on the covariates. In Table 12, we present the treatment effect for three "pseudo-outcomes": area of the plot, gender, and age. We follow the same procedure as presented in Section 4.1 for the core results. First, we pre-process the sample matching on the propensity score obtained with the remaining covariates, and then we use covariate matching (CVM) on the trimmed sample to obtain the average treatment effect of the treated, which is known a priori to be zero. We conduct the analysis both for Polytax 0/1 and Polytax 5/7. We observe that in all three cases, the "pseudo causal effect" is not statistically different from zero. This result indicates that the unconfoundedness assumption could be reasonable in our case.

Table A3: Unconfoundedness assumption for Polytax 0/1 and Polytax 5/7 datasets

	(1)	(2)	(3)
	Area of the plot	**Female**	**Age**
Polytax 0/1 Analysis			
Certified (dummy=1 if yes)	0.930	-0.032	-1.762
Standard error	[0.851]	[0.050]	[1.623]
P-value	0.274	0.524	0.278
Observations	281	281	281
Polytax 5/7 Analysis			
Certified (dummy=1 if yes)	-0.227	-0.084	-0.422
Standard error	[0.915]	[0.053]	[1.468]
P-value	0.804	0.111	0.774
Observations	747	747	747

Endnotes

[i] PEFC is the largest forest certification scheme, representing slightly less than two-thirds of the globally certified forest area (243 million hectares) versus 147.4 million hectares certified by FSC (UNECE/FAO 2012).

[ii] The Swedish Forestry Act is a complex set of laws with some legal exceptions in cases where the preservation of environmentally important areas is too onerous. See Swedish Forest Agency (2011) for details.

[iii] Exchange rate €/SEK is 9.15. These estimates are based on 65 valid answers, 50 of which reported having made a one-time payment of 17,421 SEK on average, and the other 15 reported an annual fee of 1,925 SEK on average. These figures must, however, be interpreted with caution since there is great variation in the responses (e.g., for group certificates, the direct costs are determined by each group certificate organization separately and the costs consist of an affiliation fee and a yearly fee). Depending on the size of the forest, the affiliation fee ranges from 550 SEK to 2,500 SEK and the yearly fee from 300 to 3,000 SEK (Prosilva Skogscertifiering AB, 2015).

[iv] For instance, if we consider that the average price of Norway spruce sawlogs corresponded to 466 SEK/m3, the price premium corresponds to 23.3 SEK/m3 (Swedish Forest Agency, 2014). Regarding access to markets, some indication about the market access of the certified products is found in a report by FSC (2015) indicating that that client demand for certified products is the main reason for FSC certification holders to become certified.

[v] Over the period 1999–2011, the rate of inspection has ranged from a minimum of 0.4% in 1999 to a maximum of 1.07% in 2009 (and an average of 0.6%). The Swedish Forest Agency uses a stratified sample based on geographic location with slight over-representation of forest in southern Sweden.

[vi] It was not possible to contact the other 28% of the listed forest owners because of several other reasons, including unidentified, wrong, blocked, or non-existent phone numbers. We present descriptive statistics for the difference in observed characteristics between the respondents and non-respondents in Table A1 in the Appendix.

[vii] The large number of cases for which the type of certification is unknown calls for the attention. We run a probit analysis to understand what explains this lack of information. We find that women have less information and details regarding the certification status of their plots. Single decision makers and older

owners are also less aware of the certification status of their plots. In addition, awareness seems to increase both with education, experience, and participation in forest owner associations.

[viii] We convert the number of unusual trees and shrubs into area multiplying by a factor of 0.0025, as suggested by the Swedish Forest Agency.

[ix] Note that our methodology also controls for trends. This might be especially important for the number of trees and high stumps left as the Swedish Forest Agency (2014) reports that they have increased in the period 2000-2005 compared to 1993-1999.