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Run forest run! - A cross-national study on the effect of property rights and liberty on deforestation

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Bachelor Thesis, Spring 2020

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Word count: 13977

Abstract

This thesis examines the effect of property rights and democracy on deforestation. The aim of the study is to test the two hypotheses; (1.a.) Well-defined property rights will lower deforestation and (1.b.) Higher levels of liberty will decrease deforestation. Furthermore, the test will be constructed by an extensive cross-country study of 193 countries by the method of fixed effect regressions. A contribution is made in the form of investigating the two explanatory factors, property rights and liberty, on deforestation in the scope of one study. Which there is (to the best of my knowledge) a lack of within this research area. The results gained no support for hypothesis (1.a.) meanwhile hypothesis (1.b.) found support. On the other hand, the thesis shows that property rights and liberty can affect the deforestation rate. Finally, this thesis underlines the association between the two explanatory factors under the scope, and by thus, motivates further research on the matter to fill a vital gap within the studies of deforestation.

Keywords: deforestation, property rights, political institutions, democracy.

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1. Introduction

Across continents and through human history we have seen the rise and fall of societies, that all had the ambition of achieving prosperity and safety. The industrialization in many western states has been stated a success story but is it a myth that is soon to be unraveled? A growing danger on the horizon is that the development of our modern societies has been done at the expense of the environment. The query is if the established institutions and structures from around the world today will take us on a fruitful journey, or if we are on the road to ruin.

UNFCCC acknowledge that "change in the Earth's climate and its adverse effects are a common concern of humankind" (1992, p. 2) where climate change is at the center of our concern. The increase of greenhouse gases in the atmosphere, exploration of land and seas, distortions of ecosystems and extinction of species is some of the things we begin to see between the sparser tree branches. Along with the recent forest fires in Australia and the rapid conversion of forest in the tropical amazon, the livelihood of our forest has had a growing attention in the media, by government decision makers and in the eye of the public, which has helped to embark the problem of deforestation.

Previous research on deforestation has examined different societal factors in attempts to find the root of the problem. Several studies states that higher level of deforestations rates stem from poorly defined property rights and unstable political institutions, while other studies investigates if democracies are better at safeguarding the livelihood of forest. Unfortunately, the results are somewhat inconclusive and scholars within the research field have not been able to reach over the tree tops and see how closely they stand to one another. Researchers who has examined the effect of property rights or the effect of democracy have not emphasized how closely associated their explanatory factors are to one another. Heretofore there is a lack of studies that pays attention to both property rights and democracy. By thus, there is a clear—felled area within the research field. With that in mind, the aim of this thesis is to build upon previous research in the area and further develop a framework on the matter of deforestation that relates the effect of property rights and liberty on deforestation. By an extensive cross-national study these relationships will be tested and hopefully plant a seed for future studies to fill this void in the research field.

1.1 Purpose and research question

The purpose of this thesis is to present an analysis of how national characteristics and quality of political institution affect the level of deforestation. This thesis will primarily examine the relationship between the quality of property rights and liberty on deforestation. In order to test this relationship, an extensive study of 193 countries will be conducted by the method of OLS regressions and fixed effects regressions. The aim of this is to test a broader theoretical framework by Acemoglu and Robinson (2019) that highlights the importance of a strong state and a strong society for sustainable prosperity by applying it to the issue of deforestation. By providing this large-N study based on recent data the thesis contributes to the research field within deforestation and the debate regarding which indicators shapes deforestation and what kind of affect they might have.

Along these lines, the research question set out to answer in this thesis is:

How does property rights and liberty affect deforestation?

In addition to this overarching research question two hypotheses have been specified to this study and will be presented in the end of the theory section. After this introduction previous research on deforestation will be presented, following the theoretical framework for this thesis will be accounted for. In the next section the research design is described, that includes the analytical framework, a data section and a methodological discussion. In the following section the results from the regression analyses are presented and analyzed. Thereafter a discussion will be held regarding the results and to widen the perspectives of this thesis. Lastly some final remarks will conclude the thesis.

2. Review of Previous research

The causes of deforestation have been of interest for environmentalists and is commonly studied within the field of land economics and political science. Therefore, it exists several studies within the field, many of the studies focus upon developing countries in tropical zones such as Asia, Latin America and Africa, and some are more country-specific. The motivations for a tropical focus have been that there has been an alarming rate of depilation of tropical forest (Didia, 1997, p.63). This thesis will take on a wider approach by studying cross-country data over countries geographically spread over the world, with the intention of filling a gap within the research area of deforestation. Previous literature has identified several explanatory

variables affecting the level of deforestation. Among these are population growth and population density, income, political institutions and property rights, and democracy. Researches have reached somewhat different conclusions on the topic; thus, the aim of this section is to briefly discuss previous literature for each explanatory factor separately, in a chronological order, with the ambition of laying out the controversies of the subject.

Population and conversion of land

In earlier works, population growth has been cited as the most important cause of deforestation (Deacon, 1994, p. 418). The theoretical logic assorted to it is that a growing population puts pressure on land use, by increase of demands for wood and agricultural land, infrastructure, such as construction of roads, and in search for fuel. This pressure on the land also spurs environmental degradation (Allen & Barnes, 1985, pp. 173–175). In a cross-national analysis of countries in Africa, Latin America and Asia, Allen & Barnes (1985) find support for that population growth and agricultural expansion affects deforestation. Cropper & Griffiths (1994) also find that population pressure has a significant effect on deforestation by holding constant per capita income and other relevant factors by doing an empirical study of 64 developing countries.

Income and deforestation

The argument that income affects the level of deforestation derives from a broader theoretical theory within environmental economics, namely, the Environmental Kuznets Curve (EKC). The hypothesis is that there exists an inverted U-shaped relationship between indicators of environmental degradation and economic growth. Conceptually it means that in the initial stages of development, environmental degradation appears, but when income rises it will produce initiatives to improve environmental quality (Bhattarai & Hammig, 2001, 2004). One of the first studies on the subject, related to deforestation, is Shafik & Bandyopadhyay (1992), whom explore the relationship between economic growth and environmental quality by different indicators. Regarding deforestation, they find that deforestation tend to worsen with high investment rates but tend to improve with higher incomes. Bhattarai & Hammig (2001, 2004) studies the relationship between deforestation and income across countries in Latin America, Africa and Asia and finds evidence for the EKC.

Property rights and Political Institutions

Several papers have emphasized that deforestation is shaped by institutions and policy conditions facing society. Mendelsohn (1994) focus on the economic aspects of deforestation and market failures that causes economical wasteful deforestation. He examines how poorly-defined property rights may encourage wasteful deforestation. Deacon (1994) studies the effect of insecure property rights by hypothesizing that they arise from government instability and an absence of government accountability, and measured it with the proxies; frequencies of political assassinations, riots, major constitutional changes, type of government executive, etc. The results from a cross-country data analysis of 100 countries, show consistent associations between deforestation and the political variables that reflects insecure ownership. A similar study, by Bohn & Deacon (2000), also strengthens the evidence for ownership risk and weak property rights as important causes of deforestation.

Although Bhattarai & Hammig (2001) focus on the EKC relationship between income and deforestation, they also hypothesize that institutional characteristics has an impact on deforestation and uses data from the Freedom House as a measurement of political and civil rights within countries. Hence, they also take in to account factors such as enhancement of democracy, strengthening of individual freedoms and civil liberties. The results conclude that improvements in political institutions and governance significantly reduce deforestation. Bhattarai & Hammig (2004) builds upon their previous study by adding another variable for institutions, namely quality of governance. This variable focus more on the functioning of these institutions, by summarizing values of indices for rule of law, quality of bureaucracy and corruption level. The conclusion from the study is that the EKC model for natural forest confirms that quality of governance is a critical determinant of tropical deforestation.

Culas (2007) argues that previous studies on the role of institutions on deforestation lack data that directly measure the security of property rights or the protection of them from its institutions. He indicates that variables used by Deacon (1994) and Bhattarai & Hammig (2001) only capture some of the many aspects of property rights and contractual arrangements. Therefore, he chose other alternative institutional indicators; contract enforceability of governments and the efficiency of bureaucracy. The study is performed on 14 tropical developing countries from Latin America, Africa and Asia, where the result implies that improvements in institutions that empower people through secure property rights will lead to better conservation of forestland.

Democracy and conservation of forest

The effect of democracy on the environment is more vividly discussed and more ambiguous. In the area of deforestation, previous studies have not reached unified conclusions. This is entangled in a larger discussion regarding if democracies are better at safeguarding the environment than their counterpart, autocracies, that are predatory in nature, or if democracy actually leads to environmental degradation (Gaarder & Vadlamannati, 2017). Didia (1997) constructed a democracy index variable across four regions of the tropical world, including fifty-five countries. The democracy index is built upon two components, political participation and political competitiveness. The study finds a strong relation between higher levels of democracy and a lower rate of tropical deforestation. On the other hand, Midlarsky (1998) finds evidence of the contrary. In his study he examines the relationship between democracy and the environment in 77 countries, where deforestation is one of six dependent variables under the scope. He investigates the relationship with three different measures of democracy, where all three democracy measures show that a greater level of democracy gives a greater level of deforestation, where the results from both (1) and (2) are significant.

A more recent study by Buitenzorgy & Mol (2011) suggest that both sides on the relationship between democracy and environment might be right. They find evidence of an inverted U-shaped relationship between deforestation and democracy, where countries in democratic transition tends to have the highest deforestation rates, compared to mature democracies and non-democracies. Gaarder & Vadlamannati (2017) takes on a new approach and suggests that democratic government's priority to tackle environmental degradation depends on its level of economic development. They argue that democratic countries at the lower end of economic development faces pressure from the electorates to create job opportunities through industrialization and investments which is hampering forest. While democracy at the higher end of economic development focus on sustainable economic development models where environmental protection is a key component. The result from the study of 139 countries suggests that a democratic government's priority to tackle environmental problems depends on its level if economic development and confirms their theory.

Summary of previous research

To summarize this section, previous empirical studies highlights considerable indicators that has an impact on the level of deforestation. Nonetheless, there are some controversies between

different scholars. Three remarks will be made to clarify. Firstly, on the matter of ownership and political institutions, scholars have interpreted property rights/political institutions differently which has led to the use of different measurements of the research object where some definitions are very narrow, and some are very broad. The aftermath of this is the risk of not assessing the direct effect of the security of property rights or of the institutions that protect them. Some estimates may not capture all the aspects of property rights whereas others might embody other aspects that might have an effect on deforestation but do not have any explicit reference to property rights. Therefore, considerable specification errors are likely to occur. In spite of this, the studies of ownership and political institutions points in the same direction.

The same cannot be said about the effect of democracy, which is the second remark to be outlined. Four different statements on the relationship between democracy and deforestation have been conveyed in this section. The first statement is that democracies have lower deforestation rates, whereas the second states the opposite, that democracies tends to have higher deforestation rates. The third one proclaims an inverted U-shape relationship between democracy and deforestation and the fourth affirms that the effect of democracy on deforestation depends on economic development. Hence there is a bigger dispute regarding the effect of democracy on deforestation. Scholars have also used different indicators to measure democracy that put weights on different aspects of democracy with narrow and broader definitions.

The third remark to be made is about some similarities between the studies of property rights and democracy on deforestation. When conducting the literature search on deforestation it stood out that the indicators used for property rights and democracy are closely associated with each other and some of the indicators are even used as a measurement of them both in different studies. Although, it is not startling that this might occur, since property rights and political institutions are closely related to the rule of government. What is remarkable on the other hand, is that this has not been emphasized within the research field. Consequently, there is (to the best of my knowledge) a lack of studies that pays attention to both property rights and democracy. This might even open up for explanations to why studies have reached different conclusions regarding the effect of democracy on deforestation.

With these remarks in mind, this thesis intends to fill a research gap within the field by distinguishing between different indicators on the matter and provide a study that examines both the role of property rights and liberty on deforestation by an extensive cross-national study.

3. Presentation of the Theoretical framework

This section begins with a fundamental theoretical framework that may explain why earlier studies hypothesize that indicators mentioned previously might affect the level of deforestation. The theoretical background in this section rest on broad-based theories and concepts within economics and political science that are not specifically related to deforestation. Thus, a derivation to the matter of deforestation will follow. This section is concluded with outlining two hypotheses that are drawn from this section.

3.1 From the Tragedy of the commons to the use of property rights

In 1968, Garett Hardin shaped the concept of "The tragedy of the commons". The tragedy is upon using resources as if they were infinite, when we live in a finite world. Hardin argued that whenever a scarce resource is available for many individuals to use, it will lead to over use and exploitation of the resource. He illustrated his argument with a pasture that is open for all herders, that by assumption, are rational beings. A rational person seeks to maximize his or her own gain and by such have incentives to increase their number of cattle in the pasture, because the gain of adding another animal to the pasture is bigger than the loss of additional overgrazing. Due to this, the pasture will inevitably become overcrowded and deteriorate due to overgrazing. As Hardin put it:

"Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons." (Hardin, 1968, p. 3)

Hardin's illustration of the tragedy of the commons is applicable on many other natural resources, such as forest, but only under two conditions. The first condition is that the resource is an *open-access resource*. The characteristics of this type of resources is that they are non-excludable, there is no restrictions that exclude any individual to access the resource. The

second condition is *diminishing marginal returns,* which means that as more people uses the resource the benefits from the resource must increase at a slower rate (Keohane & Olmstead, 2016, p. 93). Therefore, the issue of open-access resources is a commonly studied subject in resource and environmental economics. Field & Field (2017, pp. 192–193) states that, in most developed economies of the West the dominant solution to this issue is the use of property rights. By asserting an owner of the resource, the owner has incentives to secure that the resource is not overly exploited or degraded in quality. The shared loss of exploitation in the open access circumstances will instead be internalized to the one individual owning the resource.

Property rights of land is a common arrangement, the owner of the land then has an incentive to see to it that the land is managed properly since if the land deteriorates or loses quality the value of the land will decrease. Therefore, property rights have had a central role in forest management as a way to address the tragedy of the structure of open-access. Scholars have also stressed the importance of rules and conditions for the property rights to work efficiently. Essential for property rights is that they must be well defined, enforceable and transferable (Field & Field, 2017, p. 193). With that in mind, it is easy to draw the conclusion that well-defined property rights will lead to a better management of forest land and by such create incentives for the owner of the land to decrease the deforestation rate to protect the value of the land.

3.2 Important qualities of Democracy

A commonly held view is that democracies are better at establishing and preserve property rights than non-democratic regimes. This have also entailed an argument that democracies are better at fostering economic growth. Scholars such as Douglas North has stated that effective protection of property rights is a necessary foundation for economic growth. According to him and other researchers, authoritarian systems cannot provide a trustworthy protection of property rights, since there is no external power that can coerce the rulers to respect ownership if it is in the rulers' interest to encroach on private property. This argument has nonetheless been free from objections. Other scholars also claim that democracies can promote economic growth by public investments and collective goods, such as infrastructure, health and education, that give better functioning markets that bring about economic growth. This is based on the selectorate theory, which express that the winning coalition is larger in democracies than in autocratic

systems, hence resources will be more widely distributed in democracies (Lindgren, 2014, pp. 74-83).

Along that, Dalton (2013, pp. 87-100, 117-119) also conducts a discussion about value changes in citizen politics, where the desire for economic growth has been fringed by a concern for improving quality of life, affiliated to Inglehart's theory of value change between materialistic and post materialistic values. Dalton finds that post materialistic values can be found in advanced industrial democracies, where it has an apparent impact on politics and beyond to all aspects of society. One important impact it has is on the issue agenda, where new political issues that previously been overlooked by the political establishment has come to life, such as environmental quality, sustainable energy and gender equality. The successful dynamic quality of a democracy has therefore facilitated that environmental quality has become a significant part of the political agenda in advanced industrial democracies. Citizen groups have mobilized support of environmental issues and developed public awareness of how human activity and economic development can harm the natural environment, which also can reduce the quality of life and the sustainability of human progress.

These aspects of democracy are also connected to why some scholars believes that democracy has a positive impact on deforestation, since these post materialistic values, such as environmental protection, is better fostered in a democracy. Payne (1995) suggest five reasons why democracies are better at safeguarding the environment. The first reason is the importance of individual rights and the open marketplace of ideas. In democracies citizens are free to gather information and lobby their government for ecological purposes. Individuals are also less likely to be abused by the government or that the government suppress their criticism. Thus, environmental groups are often more successful, in democracies, at informing people and mobilize them to act on environmental problems, than in autocracies. The second reason builds upon democracies accountability to the public, which put pressure on the regime's responsiveness to ecological interests. Hence, environmentalists can punish governing parties that do not deliver on environmental protection. The third reason highlights political learning, and resonates that democratic states are more likely to draw lessons from other environmental successes and failures of others, where free-flowing information makes it more accessible and sparks innovation. The fourth reason is tied to internationalism and that democracies support international organizations as a mean of solving global problems. The last reason puts it fate into open markets and the potential advantages of markets to assessing the "green"

characteristics of democracies. Here Payne set forth that some passionate environmentalist critics of democracy emphasized private property and open markets as a shortcoming, however, he states that capitalism is not a cause of environmental degradation. Nonmarket economies have also exploited the environment quite ruthlessly, and evidence suggests that businesses in open economies finds incentives to protect the environment.

3.3 The Narrow Corridor

Further research within economics and political science have also stated that strong institutions, such as property rights, and liberty are vital parts of economic growth and prosperity for societies. Acemoglu & Robinson (2019) have spent decades of research into study how countries have emerged and developed over time. In their book *The Narrow Corridor* they have created a new big-picture framework on how some countries develop towards liberty and why some fall to despotism or anarchy and what these different paths may have to offer.

The authors state that with secure property rights individuals are free to do what they want with the greater output they produce. But if conflict and uncertainty occur, individuals do not have secure property rights on their investment and what they produce, and this discourages economic activity. In this sense a state can bring important value in that they can increase order and bring security and peace. By enforcing laws, clarity and predictability to conflicts in the process of economic transactions the state help markets and trade to expand. These are important factors to economic growth, but Acemoglu & Robinson also points out that to have sustained economic growth you also need to have innovation and continual productivity improvements. Innovation is dependent on creativity and that individuals are free to act fearlessly, experiment and chart their own paths with their own ideas. They also argue that broad-based economic opportunities are vital for economic growth. The importance of broad-based economic opportunities lays in that if opportunities are widely and fairly distributed in the society, then anyone who has a good idea for an innovation or valuable investment has the chance to carry it out (Acemoglu & Robinson, 2019, pp. 99–100, 113–144). Acemoglu & Robinson have not specifically related this to the matter of environmental degradation and deforestation, however, their reasoning can be extended and applied to this research question. I will make the assumption that sustainable economic growth and prosperity also will bring about environmental protection, improve environmental quality and a sustainable use of natural resources. Therefore, it will also lead to lower deforestation. I base this on the logic that there

will exist economic incentives to protect the environment in the ambitions of achieving a sustainable economic growth. Hence, the important qualities pointed out by Acemoglu & Robinson is also vital for obtaining environmental quality. Property rights, innovation and technological improvements that help markets and trade to expand will also strengthen environmental protection and heretofore lower the deforestation of land.

Depending on what type of state, they have different preconditions to generate the essentials of prosperity, and by extension less deforestation, as we soon shall see. Acemoglu & Robinson's (2019, pp. 63–66) theory builds upon the balance of power between the state and the society. They distinguish between three different types of states that can emerge depending on how the power is balanced. The first type of state is *the Absent Leviathan*, where a society will live without an effective state. This society is characterized by that the states and elites are too weak relative to the society. With no institutional ways of resolving and regulating conflicts, norms take on all sorts of functions. Secondly, we have *the Despotic Leviathan* where the balance of power lay in the hands of the state and the elites. In this type of state, the society is meek and ruled by the state and there is no room for liberty. The third type of state, *the Shackled Leviathan*, emerges when we have capable states matched by capable societies. Here there is a balance of power between the two where the struggle of state and society contributes to strengthening them both and by maintaining a balance between the two, liberty can flourish. Another important distinction to be made is that though a constitution may specify democratic elections or consultation, despotisms flow from the inability of the society to influence the state's policies and actions. For the Leviathan to be shackled it needs to be responsive, accountable and the society to be mobilized and actively engaged in politics.

Depending on the different characteristics of the states, they have different paths to offer. The Absent Leviathan, which is caged by the norms of the society and lacks functional institutions, it usually implies that economic opportunities are constricted for everybody. Without political institutions that increase order, enforce laws, secure ownership and predictability to conflicts that emerge in the process of economic transactions, there is no place for investment and grounds for economic opportunities to flow. Relating this to the research question at hand, the environment in an absent state is marked by the lack of property rights and the open-access of resources, fringed by overuse and inevitably deterioration of land and forest. The Despotic Leviathan may have functional institutions that provides secure property rights and can provide benefits in terms of increased order, security and peace, that helps markets and trade to expand.

State builders might even find in their interest to provide public services, infrastructure and even education to increase productivity and economic activity. But there is a backside to despotic growth, that is, the lack of popular control and mechanisms of accountability. With more power, and economic growth, comes greater monopolization of economic benefits and temptation to violate the property rights that the state was set up to protect. If the property right system is not trustworthy the incentives for owners to value their land will weaken and the risk of deforestation and exploitation will be present.

Other than that, there is an equally fundamental reason to why despotic growth has its limitations. That is the principles of innovation and continual productivity improvements for economic prosperity. Acemoglu & Robinson states that "Innovation needs creativity and creativity needs liberty" (Acemoglu & Robinson, 2019, p. 113) which is hard to sustain in a despotic state. The unequal distribution of economic opportunities between the elites and the society also hinders despotic states to make the best use of the creativity of the people. The authors illustrate this with the US and Soviets space race. The Soviet were able to organize the economy to pour resource and investments into manufacturing, but they were not able to generate sufficient innovation and productivity improvements to win the race and keep their economy from stagnating and then collapsing. Another example related to the research question, can be drawn to the creation of Vertical farming[1], where Dickson Despommier, a professor in Public and Environmental Health at Columbia University in New York, founded the idea by challenging his students to calculate how much food they could grow on the rooftops of New York. Dissatisfied with the results, Despommier suggested a creative idea that then developed into a technological advancement that will decrease the need of conversion of forest land in to agricultural land when increasing food production (Despommier, 2010). The free environment in that classroom in New York 1999 allowed for experimentation and for Despommier and his students to chart their own paths with their own ideas, something that can only flourish under liberty. Consequently, the Shackled Leviathan creates very different types of economic incentives and opportunities. Under the Shackled Leviathan individuals are free to experiment and innovate with the protection of a strong state that is upheld by a fair system of conflict resolution and law enforcement. The equal broad-based opportunities that the Shackled Leviathan provides to the elites and the society gives anyone with a good idea for an innovation

[1] Vertical farming is an innovate idea that enables to grow crops vertically on top of each other, thus, the technology increase crop yield with a smaller unit area of land required (Despommier, 2010).

or valuable investment a chance to carry it out. This bottom-up experimentation and the social mobility the shackled leviathan brings are the economic fruits of liberty.

3.4 Summary of the theoretical framework

The theoretical concepts of property rights and democracy that was presented previously in this section is reflected in the theoretical framework of a successful state that Acemoglu & Robinson have outlined. The importance of property rights to effectively manage a resource is portrayed as well as the value of social mobilization and engagement in politics to provide the public with opportunities that strengthens the society and gives them the opportunity to salience issues such as harming the natural environment can reduce the sustainability of human progress. Acemoglu & Robinson also connect the two aspects that previous scholars believe are important factors to deforestation and spurs it even further to emphasize the importance of the interaction between property rights and liberty. Innovation and productivity improvements are key components to sustainable economic growth and prosperity, therefore secure property rights and liberty can lead to a more efficient and sustainable management of natural resources. Based on these arguments, supported by theoretical reasoning and empirical groundwork, deduction of two hypotheses regarding deforestation have been made. Of that follows that the two following hypotheses to be tested in this thesis is:

(1.a.) States with more secure and well-defined property rights and stable institutions has a lower deforestation rate than states with a less stable structure.

(1.b.) Where states have equally defined property rights but differ in level of liberty, the more liberal states will have a lower deforestation rate.

4. Research design

In this section, the research design of the study will be described. First the analytical framework of the thesis will be given, followed by a presentation of the dataset used. Thereafter a discussion of the choice of method and finally, the regression model of this thesis will be outlined.

4.1 Analytical Framework

The analytical framework for this thesis builds upon the theoretical framework presented in the previous section, where the interest lays in testing the two hypotheses regarding property rights and liberty's effect on deforestation. The analytical framework is illustrated in the flowchart in figure 1. From the hypotheses we assume that better quality of property rights and a higher degree of freedom will lead to less deforestation. In this thesis, deforestation is the dependent variable, meaning that it is deforestation that is affected by the independent variables - property rights and liberty. Consequently, the question to ask the material is whether better quality of property rights and a higher level of liberty positively affects a lower deforestation rate.

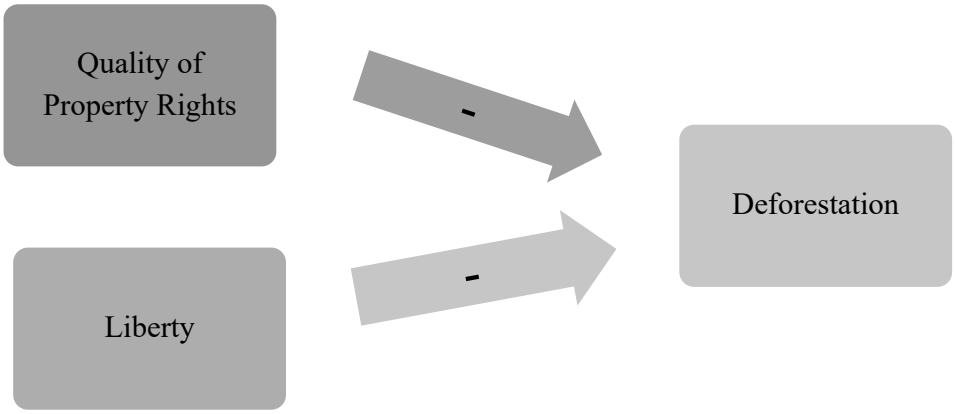

Figure 1. Analytical framework of the thesis

4.2 Data section

In this section the data for the empirical analysis is presented. To provide an extensive cross-national study, the analysis will consist of a sample of 193 countries that are recognized as member states of the United Nations. No other countries are included due to limitations of reliable data. The data obtained of the variables contain time variations, which gives a panel of data. Panel data is characterized by that each observational unit, in this context countries, is observed at two or more time periods (Stock & Watson, 2015, p. 397). The strength of using panel data is that fluctuations in the variables can be directly tied to the one unit of analysis that is being investigated, so that we can speak with bigger certainty regarding time order (Teorell & Svensson, 2007, p. 81). Due to that the data was collected from different sources, the time periods are not consistent. Therefore, this thesis is limited to the number of observations that include data from overlapping time periods. Hence, the main analysis will be constructed of observations from two time periods, 2010 and 2015. In the following section the dependent and

the independent variables will be discussed, following a motivation of the strength and weaknesses of the selection.

Deforestation

Deforestation is the dependent variable for this analysis. The indicator used for measuring the rate of deforestation is taken from the Global Forest Resource Assessment (FRA) provided by the Food and Agriculture Organization of the United Nations (FAO). The FAO has been providing data on the world's forests since 1946 at 5 to 10 years intervals. From 2000 and forward the FRA is produced every five years to provide a consistent report (FAO, 2020). Henceforth, this thesis will use data from the latest report of 2015, that covers data of 234 countries and territories between 2000 and 2015. The data is provided by two sources, the primary one, is country reports from 155 countries that together covers 98.8% of the world's forests. The second source provides data of the remaining 1.2% of forest from 79 countries and territories are provided by desk studies prepared by the FAO (2015). Since the analysis is limited to only include the 193 member states of the UN, the data on the territories will be dropped from the dataset.

This source provides data on forest area for every five year. Forest area is defined as "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ." (FAO, 2012, p. 3). By measuring the change between the years, it will provide a proxy for the deforestation rate in each country on five-year periods. Several of the previous empirical studies presented in an earlier section have also proxied deforestation rate by the use of data from the FAO, although they examined other time periods. The strength of this source is that it covers a worldwide selection of countries using the same terms and definitions for the measurement of forest over a period of time. But there are also some weaknesses to the use of this material since the change in tree cover is not distinguished between natural cover loss, such as forest fires, and human induced deforestation.

Property rights

This thesis will use property rights as one of the independent variables in the analysis, consisting of a measurement of the quality of property rights within countries provided by the International Property Rights Index (IPRI). The IPRI is an annual report dedicated to the promotion of property rights in the world by the Property Rights Alliance (PRA). The

publication started in 2007 and has provided a barometer of the status of property rights by drawing upon data from official sources that is publicly available by established international organizations. Since the data is collected from various sources, it comes in different styles and scales. Therefore, they have rescaled the data in place for the measurements to be compared accurately between countries and within the individual components included in the index (Levy-Carciente & Montanari, 2019b, p. 6).

The index is based on 10 factors that are grouped into three sub-categories: Legal and Political Environment (LP), Physical Property Rights (PPP) and Intellectual Property Rights (IPR). The indicators included in the LP are wide-ranging since they aim to provide information of the strength of a country's institution and their ability to enforce a legal system of property rights. The four components included in this subcategory is: judicial independence, rule of law, political stability and control of corruption. The PPP aims to measure the effectiveness of physical property rights within countries, for these to be effective three components are important and included in the score: protection of physical property rights, registering property and ease of access to loans. The IPR evaluates the effectiveness of intellectual property rights by measuring three components: protection of intellectual property rights, patent protection and copyright piracy (Levy-Carciente & Montanari, 2019b, pp. 6–10). The comprehensive grading scale of the IPRI ranges from 0-10, where 10 is the highest value (or most positive) and 0 is the lowest value for a property rights system a country can get. The same logic applies to the three subcomponents as well, so that they each have their own grading scale ranging from 0-10. The final IPRI score is then an average of the three components where every component is given equal importance and thus, equal weight (Levy-Carciente & Montanari, 2019a, p. 3, 2019b, p. 6-7, 10-11).

The importance of choosing a specification that is not to broad nor to narrow, in an ambition of taking all the aspects -and no additional one- of the indicator in to account was noted earlier. The IPRI has the purpose of solely measuring property rights systems in countries, heretofore it was elected as a measurement in this thesis, with the hope of that it will best represent the effects of property rights within the observation units.

Liberty

Liberty is the other independent variable included in the analysis. To measure the level of Liberty within a country, Comparative and Historical Data from the Freedom House index is

being used. Freedom House has reviewed the freedom in the world since the 1950's. Since 1973 Freedom House have provided annual scores of freedom by levels of both political rights and civil liberties in states and territories. The political rights and civil liberties are based on two separate ratings, where each rating ranges from 1 to 7. The greatest degree of freedom is represented by a score of 1 and the smallest degree is represented by a score of 7. The political rights score is based on 10 indicators that is divided in to three subcategories: Electoral Process (3 questions), Political Pluralism and Participation (4), and Functioning of Government (3). Whereas the civil liberties score is based on 15 indicators that are divided into four subcategories: Freedom of Expression and Belief (4 questions), Associational and Organizational Rights (3), Rule of Law (4), and Personal Autonomy and Individual Rights (4). The freedom rating is then based on a combined average of the political rights and civil liberties ratings, which then determines the status of a country (Freedom House, 2019, pp. 3-4,18). On that account, this thesis will use the combined average rating as a measurement of freedom.

In order to make the analysis more accessible between forest area and liberty, the data has been rescaled so that the rating is inverted. Consequently, the highest degree of freedom will have the number 7 and the lowest degree of freedom will have the number 1, going from lower to higher freedom instead, so that it is standardized to the other scales included in the analysis. Earlier empirical studies have also used Freedom House as a source, although they have used it as a measurement of different indicators, Midlarsky (1998) used it as one of the measurements of democracy, whereas Bhattarai & Hammig (2001, 2004) used it as an institutional variable. The choice of using it as an indicator in the previous studies can be debated. For this thesis I will argue that the freedom rating reflects a specification of the Shackled Leviathan where the political rights represent the strength of a state and the civil liberties represents the strength of the society. A higher level on the rating will therefore generate higher levels of liberty. By that it will provide a solid ground to test the second hypothesis in this thesis.

4.3 Choice of Method

The methodological strategy for this thesis is to use two methods of linear regression through the method of Ordinary Least Squares and through the method of Fixed effect to test the hypotheses set up for this thesis. The method of regression analysis is simply described as a way to study the relationship between variables. The core of this thesis is the aim to find a causal effect of property rights and liberty on deforestation through an extensive study. The

strength of linear regression is the use of statistical tools to provide evidence for counterfactual difference and isolation by examining the relationship between two variables by controlling for other potential explanatory factors (Teorell & Svensson, 2007, p. 159). Since the dependent variable in this thesis, deforestation, is treated as a continuous variable on an interval scale, this opens up for the possibility of using OLS regressions as a method.

Teorell & Svensson (2007, p. 204) points out that one of the main purposes of conducting an extensive study is to find evidence of the causal criterion, isolation. The use of multiple regression enables to come closer to a causal effect by isolating the effect of the independent variable by controlling for the impact of other potential causal factors. On that account, OLS regressions were chosen as one of the methods used in this thesis. Although that is a big strength of multiple regressions, it has its limitations for the reason that it may be hard to take all potential explanatory factors in to account in a study and controlling for them in one model. The unit of analysis in this thesis is countries geographically spread over the whole world, which is a complex unit of analysis, with many different characteristics that may impact the relationship between the independent and the dependent variable. As follows, there is a risk of uncertainty in reaching the casual effect of property rights and liberty on deforestation.

Through the structure of the data we might be able to unfold the problem by the use of fixed effect regression. The fixed effect regression is an extension of multiple regression conducted by the use of panel data. This method is able to control for factors without actually observing them. By studying changes in the dependent variable over time, it is achievable to eliminate the effect of factors that varies between observation units but are constant over time[2] (Stock & Watson, 2015, p. 396). There is also another dimension of the fixed effect method, which makes it possible to control for other factors that are constant between observation units but varies over time without the need of observing them, which is called time-fixed effects.[3] In my thesis I will use both country and time-fixed effects which means that I will come much closer a causal interpretation.

It is important to stress out that even though the fixed effect method is able to exclude a lot of factors that might affect the relationship between the independent and the dependent variable, it does not exclude all other potential explanatory factors. This is because the model cannot

[2] Factors relevant for this thesis may include country size, norms, religious beliefs, etc.
[3] Factors relevant for this thesis may include the presence of recession, economic crises and pandemics, etc.

exclude factors that varies between units and varies over time. Potential factors with that kind of characteristic that could affect the relationship of the independent and the dependent variables in this thesis could be population growth and income. Therefore, these variables will be used as control variables in this thesis. A short description and motivation of the variables will be conducted below:

Population

Population growth will be used as a control variable in consideration of that previous studies constituted that population has an effect on the level of deforestation. Moreover, numerous studies of deforestation have also used it as a control variable. Population will be measured by using data of Total Population compiled by the World Bank on data provided by the United Nations Population Division. The measurement is based on a definition which "counts all residents regardless of legal status or citizenship" (The World Bank, 2019b).

GDP per Capita

Considerable empirical studies have concluded that there is a relationship between income and deforestation, and it is also commonly used as a control variable in other studies of deforestation. Henceforth, this analysis will also control for GDP per Capita. The data is collected from the World Bank. GDP per capita is the total output in a country divided by its population. This thesis will use a measurement of GDP per Capita based on purchasing power parity (PPP) that is converted into international dollars and held constant to year 2011 (The World Bank, 2019a).

The use of panel data, including time variations of the observations, and the fixed effect method reduces the weakness of temporal precedence to some extension. Although having data over time, it is not an easy assignment to draw conclusions from extensive studies. The conclusions that can be drawn from it are usually sensitive to assumptions regarding how long time it takes for a certain cause to achieve a certain casual effect and even if this is something that varies between different units of analysis (Teorell & Svensson, 2007, p. 271). Although, the time order is not of a big concern in this thesis due to the implications of a reversed time order, since that would implicate that deforestation has an effect on the quality of property rights and level of liberty, which is not a likely possibility from the theoretical background of the subject. Statistical studies usually operate at a higher "structural" analytical level therefore it is harder to find intermediate mechanism(s) that explains how the independent variable affects the

dependent variable. Thus, they are not as good at giving insight to the causal process that explains *why* a certain effort leads to a certain outcome (Teorell & Svensson, 2007, pp. 271–272). Meanwhile, the intention of this thesis is not to bring an explanation on how to fully understand how property rights and liberty affect deforestation, it is rather to find evidence for in what way there is an effect.

Fixed effects regression and time-fixed effects

To be able to fully interpret the results from the analysis of the Fixed effects regressions included in this study a short depiction of the method will be conducted. The fixed effect regression method is an extension of OLS regressions that allows us to compare data over time, by doing so, it is possible to compare values of the dependent variable between time periods. The intuition behind this is described by Stock & Watson[4] (2015, pp. 400–409). By focusing on the changes in the dependent variable within each observation unit, the comparison in effect holds constant the unobserved factors that differ from one observation unit to another but do not change over time within the observation unit. To simplify we can let a_i denote these entity-fixed effects. The same logic that is used for the entity-fixed effects also applies to the time-fixed effects, but instead of focusing on the changes in the dependent variable within each observation unit, the time-fixed effect focus on the changes in the dependent variable within each time period, thus it holds constant the unobserved factors that differ from one time period to another but do not change from one observation unit to another. To simplify we can let λ_t denote the time-fixed effects. Thus, we can formulate a model for the combined fixed effect regression:

$$Y_{it} = \beta_1 X_{it} + a_i + \lambda_t + u_{it}$$

Where Y_{it} is the dependent variable, X_{it} is the independent variable, where β_1 is the effect of the independent variable on the dependent variable, a_i is the entity-fixed effects, λ_t is the time-fixed effects and u_{it} is the error term. The i denotes the number of observations ($i = 1, \ldots, n$) and t denotes the number of time periods ($t = 1, \ldots, T$).

[4] A more detailed description of the Fixed effect regressions can be found in Appendix A.

Assumptions of linear regression

In linear regression and many other statistical tests vital assumptions are set up and must be met in order to be sure that the data used is appropriate for the types of analyses you want to conduct. The OLS regression have four assumptions[5] that needs to be met and the fixed effect regression also has four assumptions[6]. Some of the assumptions are the same for both regression models, this thesis will only discuss one important assumption that applies to both the Fixed effect and the OLS regressions, namely $E\,(u_i \mid X_i) = 0$. The assumption is that the conditional distribution of the error term has a mean zero, this means that the independent variable and the error term must be uncorrelated. Thus the "other factors" that are contained in the error term must be unrelated to our independent variable otherwise there is a bias in the results, and we have failed to measure the real causal effect of the independent variable on the dependent variable. This bias is called omitted variable bias and that occurs if two conditions are true (1) if the omitted variable is correlated with the included variable and (2) when the omitted variable is a determinant of the dependent variable (Stock & Watson, 2015, pp. 170–171, 229–230). This can be related to the discussion of other explanatory factors that might influence the causal effect, that is omitted variable bias. As mentioned before, the method of fixed effect regression has a great strength in the way the method is able to control for unobserved factors and are thus much closer to reaching the assumption of $E\,(u_i \mid X_i) = 0$.

4.6 Regression Equation and Model Descriptions

Based on the method description previously mentioned and that the data has been specified, it is possible to derive a model for the regression analysis. In its fullest extent the regression model for this thesis is:

$$forest\_area = \beta_1\, property\_rights_{it} + \beta_2\, liberty_{it} + \beta_3\, population_{it} + \beta_4\, gdp\_per\_capita_{it} + a_i + \lambda_t + u_{it}$$

The model consists of the dependent variable forest area, two variables of interest, our independent variables, property rights and liberty, as well as two control variables for

[5] The assumptions of OLS regression are 1) The error term has conditional mean zero 2) The observations are independently and identically distributed 3) Large outliers are unlikely and 4) No perfect multicollinearity. For further information see Stock & Watson (2015, pp. 245–247)

[6] The assumptions of Fixed effect regression are 1) The error term has conditional mean zero 2) The variables for one entity are distributed identically to, but independently of, the variables for another entity 3) Large outliers are unlikely and 4) No perfect multicollinearity. For further information see Stock & Watson (2015, pp. 411–414)

population and income. Apart from that, the model also includes a variable for the entity-fixed effects a_i and a variable for the time-fixed effects λ_t. Lastly, we have an error term u_{it}. When conducting the analysis variables will be dropped from the model above to be able to examine the effects of the different components of the model. For clarification, the OLS regression will not include the fixed effect variables a_i and λ_t.

5. Results and analysis

In this section, the results from the thesis are conveyed and analyzed. Before that, some descriptive statistics is presented and some clarifications on how the results should be interpreted will be stated.

5.1 Descriptive Statistics

Table 1. Descriptive statistics of variables

VARIABLES	N*	Mean	Std. Dev.	Min	Max
Forest area	386	20708.04	78276.32	0	815135.6
Property Rights	242	5.33	1.53	2.5	8.6
Liberty	385	4.67	2	1	7
GDP per capita (In 1 000)	368	17	19	0.6	119
Population (In 1 000)	385	36800	138000	10	1370000

*Observe that when including all variables, the number of observations will be 242.

Table 1 contains descriptive statistics over each variable used in the analysis for the thesis. The dataset consists of variables for 193 countries, that are recognized as member states of the UN, for the years 2010 and 2015. The panel is strongly balanced since most variables have the same number of observations, except for GDP per capita and especially for property rights. The property rights variable are missing values for 80 countries in total, while this will weaken the analysis, the countries that are missing are geographically spread and not contained to a specific region. The World Bank (2019a) are missing values on GDP per capita for 10 of the member states of the UN. This means that in the multivariate analysis, the number of countries studied will decline.[7] As for the independent variables, property rights and liberty, their values are based

[7] A list of all countries included and which countries that are missing values can be found in Appendix B & C.

on scales. For the liberty variable, a country can be assigned a value between 1 to 7, hence, we can see in table 1 that we have countries that have achieved the lowest and the highest score in our dataset. The property rights variable is provided by the IPRI and in table 1 we can see that the lowest achieved score is 2.5 and the highest achieved score is 8.6 on a scale of 0-10.

5.2 Main results

The analysis will be divided in to three parts, first by looking at the effect of property rights and liberty separately and then by looking at the effect of them jointly and comparing it with the separate results discussed previously. Prior to presenting the results, a short statement regarding significance will be held.

There are two types of significance to a statistical test which is important to distinguish between since they imply different things. Commonly when talking about significance in a statistical test we think about statistical significance. Statistical significance is about measurement precision, such as if the result can be statistically separated from zero and if the causation in the sample can be found back in the population. Statistical significance is regardless of how strong the causation is, it aims to answer the question about how sure we are about our result. Substantive significance, on the other hand, aims to answer the question how much, and refers to the size of a relationship, how strong the effect of the independent variables is in the dependent variable, based on the sample (Teorell & Svensson, 2007, pp. 213–214).

Before looking at the results one by one, it is fundamental to point out that none of the results in the analysis is statistically significant. The number of observations in the analysis is low, which makes it harder to achieve a statistically significant result, due to lack of power. This means that there is a higher uncertainty to the results, which is important to have in mind when analyzing them. However, this section will focus on the substantial significance of the results and how the values from the analysis can be interpreted.

Table 2 illustrates the result of regressions of deforestation, where the dependent variable consists of forest area measured in hectare. Model (1-4) depict Ordinary Least Squares (OLS) regressions and Model (5-7) consist of Fixed effects (FE) regressions, where Model (5) contains country fixed effects and Model (6-7) contains time-fixed effects. Model (1-3) shows a non-statistically significant positive relationship between higher value of property rights and higher

Table 2. The effect of property rights on deforestation.

VARIABLES	OLS (1) Forest area	OLS (2) Forest area	OLS (3) Forest area	OLS (4) Forest area	FE (5) Forest area	FE (6) Forest area	FE (7) Forest area
Property rights	2078.5	1418.9	2483.7	-664.5	-68.03	-106.5	-184.95
	(4094.7)	(6150.8)	(3933)	(5916.9)	(238.22)	(242.3)	(242.4)
GDP per Capita		0.0743		0.3252			0.0458
		(0.4516)		(0.4366)			(0.0327)
Population			0.00016	0.00016			0.000025
			(0.00003)	(0.00003)			(0.00001)
Constant	18064.3	20038.5	7263.4	17010.9	29498.4	29658	27744.3
	(22685)	(27324.8)	(21909.5)	(26218.3)	(1269.9)	(1283.5)	(1507.3)
Mean Dep. Var.	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04
Adjusted R^2	-0.0031	-0.0072	0.0750	0.0733	0.0011	0.001	0.0848
Observations	242	240	242	240	242	242	240

Note: Results from OLS regressions in column 1-4 and results from Fixed effect regressions in column 5-7, where column 6-7 contains time-fixed effects. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

amount of forest area. Hence, it indicates that countries with higher value of property rights tends to have a larger amount of forest area. In terms of magnitude, an increase with one higher value on the property rights index increases the forest area by approximately 2100 hectare (Model 1). Since the lowest obtained score on the IPRI scale was 2,5 and the highest score obtained was 8,6, the results would indicate that a country with the lowest obtained score would have approximately 12 500 hectares of forest less than a country with the highest obtained score. When GDP per capita is included as a control variable (Model 2) the effect of property rights weakens with almost one third. Turning to our other control variable, population, the effect of property rights strengthens when holding it constant (Model 3). The results from Model (2-3) could indicate an omitted variable bias in model (1) if GDP per capita and population is not controlled for. At the same time the standard errors for the regressions in Model (1-3) are very large, thus the difference for a country with an increase with one higher value on the IPRI score could just as well not give any difference in forest area. When controlling for both population and GDP per capita (Model 4) the relation between property rights and forest area becomes negative instead. The result from this would mean that higher value of property rights system generates a lower amount of forest area, which contradicts the results in Model (1-3), since the result varies a lot between the models it indicates a bigger uncertainty regarding the results. The standard error in column 4 is also very high.

The result from the fixed effect regressions in Model (5-7) can be interpreted in the same way as the OLS regressions. When including entity-fixed effects (Model 5), controlling for unobserved factors that varies across entities but not over time, the relationship between property rights and forest area is negative and not statistically significant. The negative relationship indicates that a higher value of property rights system would lead to a lower amount of forest area. Where a one increase on the IPRI ranking would cause a decrease of forest area with approximately 70 hectares (Model 5). In Model (6) time-fixed effect, that control for unobserved variables that are constant between countries but varies over time, is included. Once the time-fixed effects are included the effect strengthens as the b-coefficient increases from approximately 70 to 105. The magnitude in the fixed effect regressions are lower than in the OLS regressions and the standard error is lower in proportion as well, which points to that there are other unobserved variables that the fixed effect regression is able to control for, which the OLS regression does not account for. The fixed effect regressions seem to be closer to the causal effect of the independent variable on the dependent variable, thus, hereafter the analysis will mainly focus on the results from the Fixed effect regressions in the following tables. Furthermore, when adding the control variables in Model (7) the effect strengthens even more, with an increase from around 105 to 185. In terms of magnitude, a change from the lowest achieved IPRI score to the highest achieved IPRI score would lead to a change of approximately 1110 hectares less forest (Model 7). To put the value in to relation, the mean of the dependent variable can be found in the regression table. For a country with the same amount of forest as the mean, the change mentioned previously would lead to about a 5,3% decrease of forest area.

Table 3 contains results of regressions of deforestation, where Liberty is the independent variable. Model (1-4) consist of OLS regression where the results suggest a negative relationship between liberty and forest area, which means that less democratic countries tend to have a larger amount of forest area. As for the fixed effects regressions in Model (5-7) there is still a negative relationship, but much smaller, between liberty and forest area. The coefficients for the fixed effects regressions are much lower than for the OLS, which means that a change on the freedom rating causes a smaller change in forest area. The standard errors are very large here as well, relative to the value of the coefficients. When going from only entity-fixed effects (Model 5) to also include time-fixed effects (Model 6) the effect of liberty strengthens where the b-coefficient decreases by a half. On the other hand, when including the control variables, the relationship between liberty and forest area weakens considerably as the effect changes from around 19 to 2. In terms of magnitude, a change from the lowest score of

Table 3. The effect of liberty on deforestation.

VARIABLES	OLS (1) Forest area	OLS (2) Forest area	OLS (3) Forest area	OLS (4) Forest area	FE (5) Forest area	FE (6) Forest area	FE (7) Forest area
Liberty	-1031.8	-2117.5	-158.9	-1151.9	-12.53	-18.72	-1.57
	(2004.8)	(2236.1)	(1930.9)	(2140.7)	(103.8)	(103.6)	(105.3)
GDP per Capita		0.2857		0.3214			0.0238
		(0.2281)		(0.2178)			(0.0215)
Population			0.00017	0.00017			0.00002
			(0.000028)	(0.000028)			(9.53e-06)
Constant	25563.4	26610.2	15209.2	14870.8	20801.8	20787.5	20284.1
	(10183.2)	(11121.9)	(9941.6)	(10794.1)	(485.7)	(484.7)	(752.6)
Mean Dep. Var.	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04
Adjusted R^2	-0.0019	-0.000	0.0867	0.0886	0.0007	0.0003	0.095
Observations	385	367	384	367	385	385	367

Note: Results from OLS regressions in column 1-4 and results from Fixed effect regressions in column 5-7, where column 6-7 contains time-fixed effects.
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

liberty to the highest score would lead to a decrease in forest area with approximately 9 hectares (Model 7). For a country with the same amount of forest area as the mean, this change is very small.

In Table 4 we examine how the independent variables, property rights and liberty, affect our dependent variable, forest area. The OLS regressions in Model (1-4) shows that there is a positive relationship between property rights and forest area, and a negative relationship between liberty and forest area. The direction of the relationships in the OLS regression is similar to the results obtained in the previous table when we studied the independent variables separately. Interestingly enough, the effect of both liberty and property rights on forest area is inverted in the fixed effect regressions (Model 5-7). This would mean that a higher value of property rights would bring around less forest area and a higher level of freedom would lead to more forest area. The value of the coefficients in the fixed effect regression are also a lot smaller than in the OLS regressions. In terms of magnitude, one increase in liberty would lead to an increase of 68 hectares of forest whereas one increase in property rights would lead to a decrease of 61 hectares of forest approximately (Model 5). Adding time-fixed effects (Model 6) does not have any bigger impact on the relationship between liberty and forest area, but it has on the relationship between property rights and forest area. The effect of property rights strengthens as the coefficient decreases with almost two thirds. Lastly, by adding the control variables, and thus reaching the fullest extent of the regression model depicted for this analysis, the effect of both the independent variables strengthens considerably (Model 7). The strength of the liberty

Table 4. The effect of liberty and property rights on deforestation.

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	FE (5)	FE (6)	FE (7)
VARIABLES	Forest area	Forest area	Forest area	Forest area	Forest area	Forest area	Forest area
Liberty	-4284.5	-4729.5	-1928.97	-1253.4	68.224	67.348	109.91
	(4262.8)	(4524.3)	(4133.4)	(4416.7)	(162.42)	(162.58)	(160.49)
Property Rights	5205.5	6306.4	3886.3	653.38	-60.642	-99.075	-175.25
	(5142.5)	(7725.1)	(4955.1)	(7530.7)	(239.75)	(243.84)	(243.39)
GDP per Capita		-0.0696		0.2844			0.0478
		(0.472)		(0.4605)			(0.0329)
Population			0.00016	0.00016			0.00003
			(0.00003)	(0.00003)			(0.00001)
Constant	22430.75	20289	9368.9	17110.1	29124.2	29288.2	27077.7
	(23096.8)	(27320.5)	(22404.3)	(26271.9)	(1554.9)	(1567.4)	(1797.4)
Mean Dep. Var.	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04	20708.04
Adjusted R^2	-0.003	-0.0068	0.072	0.0697	0.0048	0.0045	0.0845
Observations	242	240	242	240	242	242	240

Note: Results from OLS regressions in column 1-4 and results from Fixed effect regressions in column 5-7, where column 6-7 contains time-fixed effects.
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

coefficient increases from around 67 to 109 and the strength of the property rights coefficient decreases from 99 to 175. In terms of magnitude, a change from the lowest score of liberty to the highest leads to an increase of 660 hectares of forest. For a country with the same amount of forest area as the mean, this would cause a 3,2% increase of forest approximately. On the other hand, a change from the lowest to the highest achieved score of property rights would cause a decrease of around 1050 hectares of forest. For a country with the same amount of forest as the mean it would lead to a 5,1% decrease of forest approximately.

It is also interesting to compare the results of the fixed effect regressions in the different tables, to see if there is a change in our independent variables when including them both. For the relationship between property rights and forest area the results in Table 2 Model (5-7) and the results in Table 4 Model (5-7) are quite similar. The relationship is negative in both tables and including time-fixed effects and control variables in to the models has the same type of effect. The only difference is that the b-coefficients is a bit weaker in Table 4 when liberty is included, compared to Table 2. The results for liberty in Table 3 and Table 4 deviates more. Without controlling for property rights (Table 3) the relationship between liberty and forest area is negative, while the results in Table 4 when property rights are controlled for, the relationship between liberty and forest area is positive. In Table 3 we can see that time-fixed effect strengthens the relationship meanwhile controlling for income and population weakens the result significantly. This is not consistent with the results in Table 4, since the effect strengthens when including time fixed effects and controlling for income and population.

To summarize this analysis, the result is fluctuating a lot between the different models and by the use of the different methods. This would indicate that there are a lot of variables that affects the relationship of property rights and liberty on deforestation and that there is a bigger uncertainty regarding the results. The results are also not statistically significant which makes it harder to be certain that the effect is statistically separated from zero. Even if having that in mind, there is one thing I want to point out in this summary. There was a big difference between the OLS regressions and the Fixed effect regressions which demonstrates that there are factors that varies between countries and over time that has vital impacts on the independent and the dependent variables. Thus, the use of panel data and the method of Fixed effect is a big strength in this analysis. With this in mind, the most important results from this regression analysis can be found in Table 4 Model (5-7), where we are most likely closest to the causal effects of our independent variables. Based on the results of the Fixed effects in Table 4, this thesis would suggest that liberty has a positive effect on forest area and that property rights has a negative effect on forest area.

The hypotheses that were set out to be tested in this thesis was; (1) States with higher quality of property rights has a lower deforestation rate and (2) States with equally defined property rights but higher level of liberty will have a lower deforestation rate. The main result from the Fixed effect regression in Table 4 suggests that hypothesis (1) is invalid as the results contradicts the relation that is hypothesized. On the other hand, the results do not contradict the relationship stated in the second hypothesis. The results from this empirical study is therefore unexpected since one of the hypotheses holds and the other do not. In the next section a more extensive discussion about the implications of the results will be held.

6. Discussion

Underlying causes of deforestation has been an object of research within land economics and political science. However, controversies still exist within the research field and the results are not conclusive. Studies of property rights and studies of democracy on deforestation have neglected to acknowledge one another and how closely associated their explanatory factors are. The aim of this thesis was to combine a study on how both property rights and liberty affects deforestation – something that (to the best of my knowledge) has not been emphasized in previous empirical studies. Furthermore, the intention was to answer the research question "How does property rights and liberty affect deforestation?" by testing two hypotheses on an

extensive empirical study of cross-country observations. In this section the ambition is to discuss the results from the regression analysis further. Its outcome and potential implications this thesis may have and what insights it can give for future research.

Hypothesis (1.a.) stated that countries with more secure and well-defined property rights and stable institutions has a lower deforestation rate than states with a less stable structure. Although, this relationship did not find any support in the results from the empirical analysis, instead the analysis indicated the opposite relationship, that states with stronger property rights system has a higher deforestation rate.

It is a commonly held view within resource economics that property rights internalize the value of the land and gives the owner incentive to manage the land properly to not lose the value of the land. Thus, the reasoning that follows is that stronger property rights systems will lead to lower deforestation because loosing value of the land is not desirable. On the other hand, if the incentives were different, like if there is a bigger value to the land by converting the forest into agricultural land, stronger property rights systems will not lead to a lower deforestation rate. This exposes a potential short coming in the theory since secure property rights in itself does not bring about lower deforestation rates, it also rests upon incentives of the owners. Nonetheless, the results from the regression analysis contradicts previous studies on the matter. As indicated in the section regarding previous research, studies have used different proxies to measure the quality of property rights and its institutions, henceforth this might explain why they have reached another conclusion, due to specification errors. Broader measurements of property rights might embody other aspects that has the wanted effect on deforestation but is not directly connected to property rights. Deacon's use of political assassinations, riots and type of government executive may rather reflect an authoritarian state than insecure property rights, for example. Regardless of that the measurements in previous examinations have been narrow or broad, all the results have leaned in the same direction. Therefore, it is also important to be humble and open to that there can be weaknesses in the results in this thesis. Likewise, there could be specification errors in previous studies they may exists in this study as well. The use of the IPRI as a measure of the quality of property rights systems within countries have never been conducted before in this research field. The fall out of missing values for 80 out of 193 countries might have caused a bias in the results. Even though the missing values seemed to be geographically spread, there might be other specific reasons to why these countries are not included in the IPRI score that could bias the results. The number of observations is also quite

low, which can bring about a higher uncertainty to the results. A way to address these shortcomings would be to collect a more comprehensive data material, by including additional time periods. The strength of this would not only be in the increase of observations, but also by analyzing changes for several time periods and not only between two periods of time. Lastly, all the variables that might have an influence on this outcome may not have been examined. All though the choice of method enabled to control for many unobservable factors, unobserved variables, that differ between countries and over time, could influence the outcome on this relationship. A way to address this would be more research on deforestation to better understand if there might be other causes to deforestation that has not yet been emphasized. If the relationship seen in the regressions is true, the results generates some questions of what might explain why better quality of property rights spurs higher deforestation rates. Here, more research and theory-developing are needed, since this thesis is not able to support any wider claims of this relationship.

Hypothesis (1.b.) stated that states that have equally defined property rights but differ in level of liberty, the more liberal states will have a lower deforestation rate. Contrary to hypothesis (1.a.) this hypothesis founds supports in the results from the regression analysis. The result therefore suggests that liberty can foster lower deforestation.

The theoretical framework has built a good foundation for why there might be a positive relationship between liberty and deforestation by emphasizing several explanations. These reasons can be boiled down in to three main components. The first one highlights that liberty provides vital governmental qualities that can be found in democracies. Secondly, liberty gives way to post materialistic values to flow in the society and influence politics, as has been found in advanced industrial democracies. The third component is based on that liberty is crucial for sustained economic growth and, by assumption, economic growth and prosperity can bring about environmental protection. The opportunities to provide a more detailed answer to *how* and if any of the components are more relevant than others to explain liberty's effect on deforestation is rather limited due to the choice of method in this thesis. The regression analysis has suggested a relationship between the two, that is in line with the hypothesis (1.b), but it provides less information on what underlying mechanisms that can stimulate this relationship. Further research is needed to provide better insight on to this matter. Be that as it may, the result from this thesis contradicts some of the previous studies on democracy and deforestation.

Therefore, it is once again important to point out that there might be shortcomings to the results of this thesis, where potential solutions to tackle these problems have been addressed.

The overarching framework of this thesis, how the two hypotheses are related and why they are interesting to investigate within the scope of one study was first derived from previous research by the motivation that there is a gap within the research field. The theoretical framework based on Acemoglu and Robinson, provided a background to how the two independent variables were associated. The results from this thesis contradicts the first hypotheses but supports the second, hence this could implicate that there are shortcomings to the theory. The theoretical reasoning rest on the assumption that economic growth and prosperity will bring about higher environmental quality. As argued previously in this discussion, economic incentives might not be reliable for this claim since it relies on other causes that drives forth these incentives. It does not by default make the theory invalid, henceforth I do not want to elaborate on this any further since more research is needed to support such statements.

Although the overarching theory that associated property rights and liberty on the matter of deforestation may be at fault, an important finding outside the scope of the hypotheses was found. The relationship between liberty and deforestation changed from a negative to a positive effect when controlling for property rights, which provides evidence for a relationship between the two variables that strengthens the importance of emphasizing the research gap in this research field. Lastly, I hope that this finding may contribute to spark a scientific interest to fill this void within the research area of deforestation in the future.

7. Conclusion

The main purpose of this thesis was to examine how property rights and liberty affects deforestation. Drawing on findings from earlier studies and based on the theoretical framework the question; “How does property rights and liberty affect deforestation?” were set out to be answered by testing two hypotheses. The regression analysis of cross-country data led to inconclusive results. The first hypothesis – that secure and well-defined property rights leads to lower deforestation rates – gained no support. Instead the relationship seems to be the other way around. However, the second hypothesis – greater level of liberty generates less deforestation – found support. The implications of this was then debated in the discussion, where emphasis on theoretical improvements and identification of underlying driving forces of

the explanatory variables was encouraged for future research. Lastly, this thesis has contributed to shed a light on a void, within the research field of deforestation, that needs to be filled.

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Appendix A. Fixed effects regressions

This method description is based on the Chapter of Fixed effects in the book Introduction to Econometrics. For further reading on the method please refer to Stock and Watson (2015, pp. 396–430).

Fixed effects regression and time fixed effects

The fixed effect regression method allows us to compare data over time, by doing so, it is possible to compare values of the dependent variable between time periods. By focusing on the changes in the dependent variable within each observation unit, the comparison in effect holds constant the unobserved factors that differ from one observation unit to another but do not change over time within the observation unit. We can illustrate this by an example with two time periods, where we let Z_i denote the factors that was mentioned previously where i denotes the number of the observation unit ($i = 1, \ldots, n$). Then the linear regression for period 1 is:

$$Y_1 = \beta_0 + \beta_1 Xi_1 + \beta_2 Z_i + u_{i1}$$

Where Y_1 is the dependent variable in period 1, β_0 is the intercept, X_1 is the independent variable in period 1 and β_1 is the effect of the independent variable on the dependent variable in period 1 and u_{i1} is the error term of period 1. Consequently, the linear regression for period 2 is:

$$Y_2 = \beta_0 + \beta_1 X_{i2} + \beta_2 Z_i + u_{i2}$$

To measure the change between time periods we subtract period 1 from period 2, which eliminates the effect of Z_i.

$$Y_2 - Y_1 = (\beta_0 + \beta_1 X_{i1} + \beta_2 Z_i + u_{i1}) - (\beta_0 + \beta_1 Xi_2 + \beta_2 Z_i + u_{i2})$$

$$Y_2 - Y_1 = \beta_1 (X_{i2} - X_{i1}) + u_{i2} - u_{i1}$$

To simplify we can let $a_i = \beta_0 + \beta_2 Z_i$. Where a_i is known as the entity fixed effects that comes from the variables that varies across entities but not over time. Thus, we have arrived at the fixed effect regression:

$$Y_{it} = b_1 X_{it} + a_i + u_{it}.$$

Where i denotes the number of observations ($i = 1, \ldots, n$) and t denotes the number of time periods ($t = 1, \ldots, T$).

As mentioned previously the fixed effect regression also allows us to hold constant unobserved factors that are constant over the observation units but changes over time by the use of time fixed effects. The same logic that is used for the fixed effects applies to the time fixed effects, but instead of focusing on the changes in the dependent variable within each observation unit, the time fixed effect focus on the changes in the dependent variable within each time period, thus it holds constant the unobserved factors that differ from one time period to another but do not change from one observation unit to another. We can illustrate this with an example with two observation units, where we let S_t denote the factors that are constant between observation units but changes over time. The linear regression for observation unit one is then:

$$Y_1 = \beta_0 + \beta_1 X_{1t} + \beta_2 S_t + u_{1t}$$

And the linear regression for observation unit two is:

$$Y_2 = \beta_0 + \beta_1 X_{2t} + \beta_2 S_t + u_{2t}$$

To measure the change between observation units we subtract observation unit 1 from observation unit 2, which eliminates the effect of S_t.

$$Y_2 - Y_1 = (\beta_0 + \beta_1 X_{1t} + \beta_2 S_t + u_{1t}) - (\beta_0 + \beta_1 X_{2t} + \beta_2 S_t + u_{2t})$$

$$Y_2 - Y_1 = \beta_1 (X_{2t} - X_{1t}) + u_{2t} - u_{1t}$$

To simplify we can let $\lambda_t = \beta_0 + \beta_2 S_t$. Where λ_t is known as the time fixed effects that comes from the variables that varies over time but not across entities. Thus, we have arrived at the time fixed effect regression:

$$Y_{it} = b_1 X_{it} + \lambda_t + u_{it}.$$

Lastly, the entity fixed effects and the time fixed effects can be combined in to one regression model so that we can control for both variables that are constant over time but vary across

observation units and variables that are constant across observation units but vary over time. The combined fixed effect regression is then:

$Y_{it} = b_1 X_{it} + a_i + \lambda_t + u_{it}$,

Where a_i is the entity fixed effects and λ_t is the time fixed effects.

Appendix B. List of countries

A
Azerbaijan
Afghanistan
Albania
Algeria
Andorra
Angola
Antigua and Barbuda
Argentina
Armenia
Australia
Austria

B
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Hercegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi

C
Cabo Verde
Cambodia
Cameroon
Canada
Central African Republic
Chad
Chile
China
Colombia
Comoros
Congo (Democratic Republic of the)
Congo (Republic of the)
Costa Rica
Cote d'Ivoire
Croatia
Cuba
Cyprus
Czech Republic

D
Denmark
Djibouti
Dominica
Dominican Republic

E
Ecuador
Egypt (Arab Republic of)
El Salvador
Equatorial Guinea
Eritrea
Estonia
Eswatini (Swaziland)
Ethiopia

F
Fiji
Finland
France

G
Gabon
Gambia (The)
Georgia
Germany
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana

H
Haiti
Honduras
Hungary

I
Iceland
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy

J
Jamaica
Japan
Jordan

K
Kazakhstan
Kenya
Kiribati
Korea (Democratic People's Republic of)
Korea (Republic of)
Kuwait
Kyrgyz Republic

L
Lao (People's Democratic Republic)
Latvia
Lebanon
Lesotho
Liberia
Libya
Liechtenstein

Lithuania
Luxembourg

M
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia (Federal State of)
Moldova
Monaco
Mongolia
Montenegro
Morocco
Mozambique
Myanmar

N
Namibia
Nauru
Nepal
Netherlands
New Zealand
Nicaragua
Niger
Nigeria
North Macedonia
Norway

O
Oman

P
Pakistan
Palau
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal

Q
Qatar

R
Romania
Russian Federation
Rwanda

S
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Saudi Arabia
Senegal
Serbia
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
Somalia
South Africa
South Sudan
Spain
Sri Lanka
Sudan
Suriname
Sweden
Switzerland
Syrian Arab Republic

T
Tajikistan
Tanzania
Thailand
Timor-Leste
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Tuvalu

U
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Uzbekistan

V
Vanuatu
Venezuela(Bolivarian Republic of)
Vietnam

Y
Yemen (Republic of)

Z
Zambia
Zimbabwe

Appendix C. List of missing countries

Property Rights

A
Afghanistan
Andorra
Angola (2010)
Antigua and Barbuda

B
Bahamas
Bahrain
Barbados
Belarus
Belize
Benin (2015)
Bhutan
Bosnia and Hercegovina (2010)
Brunei Darussalam (2015)

C
Cabo Verde
Cambodia
Central African Republic
Comoros
Congo. Dem. Rep. (Kinshasa)
Congo. Rep. (Brazzaville)
Cuba

D
Djibouti
Dominica

E
Ecuador (2015)
Equatorial Guinea
Eritrea
Eswatini (Swaziland)

F
Fiji

G
Gabon (2010)
Grenada
Guinea
Guinea-Bissau

H
Haiti (2010)

I
Iran (2010)
Iraq

K
Kiribati
Kyrgyz Republic (2015)

L
Lao PDR
Lebanon (2010)
Lesotho
Liberia
Liechtenstein

M
Maldives
Marshall Islands
Micronesia. Fed. Sts.
Monaco
Mongolia
Myanmar

N
Namibia
Nauru
Niger
North Korea. Dem. Rep.

P
Palau
Papua New Guinea

R
Rwanda

S
Samoa
San Marino
Sao Tome and Principe
Seychelles
Solomon Islands
Somalia
South Korea. Rep.
South Sudan
St. Kitts and Nevis
St. Lucia
St. Vincent and the Grenadines
Sudan
Suriname

T
Tajikistan
Thailand
The Gambia
Timor-Leste
Togo
Tonga
Turkmenistan
Tuvalu

U
Uzbekistan

V
Vanuatu

GDP per capita

Syrian Arab Republic
Andorra
Cuba
Djibouti
Liechtenstein
Monaco
North Korea. Dem. Rep.
Somalia
Venezuela. RB (2015)
Eritrea (2015)

Population

Eritrea (2015)

Liberty

South Sudan (2010)