TO SAVE THE LAST TREE: A CASE STUDY OF THE INTERNATIONAL TROPICAL TIMBER AGREEMENTS

By

KENDALL ASHLEY HOUGHTON

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Approved by:

James C. McKusick, Dean
The Davidson Honors College

Helen Naughton, Faculty Mentor
Department of Economics

Jeff Bookwalter, Faculty Reader
Department of Economics
Between 1990 and 2005, the tropical nation Comoros lost approximately sixty percent of its nation’s forests to clear-cutting (NASA 2012). Although the starkest example of deforestation during that time period, Comoros’ loss of wilderness represents a long-standing trend among all tropical nations. The first of the International Tropical Timber Agreements (ITTA) was created in 1983 to reduce the rate of timber harvesting in tropical countries (ITTO 2012). Despite a second and third agreement in 1994 and 2006 respectively, deforestation continues. Treaties rarely garner complete compliance, and when they do not it is important to understand how and where they fail. If any more effort is to be placed on strengthening and renewing the ITTA in lieu of other approaches, governments ought to be well informed of the likely results and the necessary adaptations. This study utilizes timber exports to evaluate whether or not the ITTA have been effective. GDP, GDP per capita, and population are introduced as additional explanatory variables through econometric regression on panel data. The findings show inconclusive results for the 1983 ITTA, but that the 1994 ITTA was effective overall. It is important to note that effectiveness, in this study, is defined as member nations’ compliance with the terms of the ITTAs. The analysis of timber exports is limited to only those timber goods specifically mentioned in the ITTA documents themselves. The findings in this study suggest that while there has been a measure of success, there is still more work to be done. Overall, there should be significantly more research into the terms of the ITTAs and the impact of their implementation.
Acknowledgements

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1. Introduction

Between 1990 and 2005, the tropical nation Comoros lost approximately sixty percent of its nation’s forests to clear-cutting (NASA 2012). While this remains the strongest example of deforestation during that time period, Comoros’ loss of wilderness represents a long-standing trend among all tropical nations. In 1983, the International Tropical Timber Organization (ITTO) created an international treaty dedicated to reducing the rate of deforestation and promoting environmental sustainability in these countries (ITTO 2012). Since then, there have been two more ITTO agreements dedicated to the same end. Have the International Tropical Timber Agreements (ITTA) been effective, either individually or as a unit?

Preservation of tropical forests concerns the international community for many reasons, of which greenhouse gases emissions and the reduction of species diversity are the most widely mentioned. The Intergovernmental Panel on Climate Change estimates that 20 percent of human greenhouse gas emissions result from tropical deforestation (Zarin 2012). In context, these emissions outweigh those created by the entire global transportation industry (Burgess et al. 2012). Additionally, the extinction of species that reside in tropical forests is a concern. If deforestation continues to progress as it has for the past fifty years, 47% of tropical habitat may be gone by 2050 (Feeley et al. 2012).

While many politicians and environmentalists applauded the formation of the ITTAs, little empirical work has been done to evaluate their effectiveness (Chirchi 2004). International agreements rarely garner complete compliance, and when they do not it is important to understand how and where they fail. Through this kind of reflection, it is possible to improve upon the work that has been done. Furthermore, an environmental agreement is only one of many viable policy options. If any more effort is to be placed on strengthening and renewing the ITTAs in lieu of other approaches, governments ought to be well informed of the likely results.

2. Background

2.1 Environmental Agreements

The social sciences have evaluated international agreements extensively over the past fifty years. In the beginning, most effort was dedicated to critiquing the language of the agreements and the terms contained within them. Over time, the discipline deepened into retrospective papers on compliancy with agreements. “Effectiveness” was expanded to mean both the terms of the agreement, and the results of it. Despite this advancement in technique,
little work has been done by way of empirical evaluation. The ITTAs, in particular, remain woefully under-researched.

2.2 The International Tropical Timber Agreements

After the creation of the first agreement in 1983, Johnson (1985) published predictions for its future effectiveness. In his paper, he characterizes the ITTA as an opportunity for sustainable development, but not a guarantee. He recommends that participation in the ITTA come with an explicit offer of financial aid from the ITTO. Jacobson and Weiss (1995) echoes this sentiment of skepticism in regards to the 1983 ITTA and furthered the conclusion to the 1994 ITTA in their aggregate paper on treaty compliance. This majority opinion is succinctly expressed by Wilson (1996), who describes the agreements as weak due to the lack of strict regulations. Like those before, however, he articulates the hope and possibility the agreements present. In light of the developing third agreement, Flejzor (2005) studies the framework of the previous agreements and finds the need for adjustments in the document language as well.

Interestingly, the sole quantitative review of the ITTAs finds that the 1983 and 1994 ITTAs have been effective. Chirchi (2004) uses exports as a proxy for deforestation to find that participation decreases deforestation. The study is not a comprehensive examination, however, as it compares eight member countries to eight non-members. Additionally, no other explanatory variables are employed.

This study builds upon the work previously completed by deepening the method used for evaluation. As in Chirchi’s study, a measure of deforestation is used to enhance impartiality in the evaluation. Similarly, this study utilizes timber exports as a proxy for deforestation, following the precedent set by Chirchi. This research introduces additional explanatory variables in an attempt to control for other economic drivers of timber exports.

3. Data and Descriptive Statistics

International agreements can be difficult to evaluate due the scope of the goals contained in the documents and the often large area of influence. In the case of this research, the ITTAs span thirty years and over sixty countries. In order to reduce the question of effectiveness to a manageable size, the study relies on previous literature and developed theory to select relevant variables. The resulting sample is an unbalanced panel covering treaty participation, timber exports, population, and gross domestic product for all tropical countries from 1970 to 2011. Although the first agreement began in 1983, the sample begins earlier in order to effectively
gauge export trends before the introduction of the first agreement. The 1994 ITTA ended in December of 2011, and so the sample extends through this year. The abovementioned variables are recorded on a country level for the time period mentioned.

The sample is limited to tropical countries as defined by the International Union for Conservation of Nature, who regard a nation as tropical if part or all of its landmass lies between the Tropic of Cancer and the Tropic of Capricorn (IUCN 1986). The study chooses to concentrate on the Tropics because the agreements focus on tropical deforestation. Additionally, the agreement members are divided into “Producer” and “Consumer” countries, with all producer countries residing in the Tropics (ITTO, 1986). This study focuses on modeling the producer countries, which are more directly in charge of deforestation.

In this study, treaty success is defined as a decrease in deforestation for member countries in the production category. Unfortunately, there is a lack of consensus among deforestation researchers on the best way to measure forest removal. Chiu (2012) and Scrieciu (2007) use arable land as a proxy for deforestation, relying on the substitutability of arable land with forestland. Other sources including Bhattari and Hammig (2001), Culas (2006), and Ewers (2005) use the Food and Agricultural Organization of the United Nations (FAO) Production Yearbook for forest cover.

This study relies on FAO timber export records as a way to proxy deforestation. The assumption is that a decrease in trade corresponds to a decrease in deforestation. This is a suitable measurement in regards to the ITTAs, as the documents target trade as a means of enforcement by dividing participant countries into producer and consumer nations. Additionally, the FAO trade records maintain reliable data from 1970 forward, in contrast to the other mentioned measurements, which begin in the 1990’s. The increased time span allows for better understanding of the impact of the 1983 ITTA. Within the FAO record, each country’s exports are broken into individual timber product categories and measured in thousand cubic meters. The ITTAs specifically targets logs, sawn wood, veneer sheets, and plywood (ITTO 1983). As such, this study uses “Industrial Rwd Wir C” and both “Industrial Rwd (NC) other” categories as the record of “Logs.” “Veneer sheets” and “Plywood” are titled categories in the database, and the study uses both “Sawnwood (C)” and “Sawnwood (NC)” for the agreement category “sawn wood”.

3
The International Environmental Agreements Database Project provides records of treaty participation on a country level for each individual year. Countries are able to join an ITTA at any point, leading to the importance of recording the participation years of each individual nation, rather than assuming a blanket effect from 1983 onward. For each year, treaty participation is represented by a dummy variable of one for membership or zero for non-membership. Countries that are not specifically listed in the treaty database are given a zero for non-membership in every time series.

The data also include the country specific explanatory variables of gross domestic product (GDP) and country population. These are meant to account for changes in the countries’ economies and overall demographics. The United Nations’ Department of Economic and Social Affairs provides the population figure in thousands and the data for GDP comes from the United Nations’ Statistics Division. The latter record has been adjusted to real million United States dollars in 2005 terms. GDP per capita, as well as its squared form GDP per capita$^2$, are generated within the model using the population and GDP data from above. As a result, GDP per capita is recorded as thousand dollars per citizen and GDP per capita$^2$ as millions of dollars per citizen.

The descriptive statistics for the variables mentioned above are summarized in Table 1 below. In addition to these variables, GDP and bilateral distance data for all countries is used to calculate a market potential variable—the distance-weighted sum of other countries GDP. The distance data are provided by CEPII (CEPII).

Although there have been countless country specific effects and unique features over the past thirty years, the study aims to gauge the effectiveness of the agreements overall. Additionally, the study looks broadly by using an extended time period and including all tropical nations.

Table 1. Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber Aggregate</td>
<td>370</td>
<td>2534.27</td>
<td>4864.83</td>
<td>0.73</td>
<td>27929.77</td>
</tr>
<tr>
<td>Plywood</td>
<td>2203</td>
<td>190.56</td>
<td>920.34</td>
<td>0</td>
<td>9761</td>
</tr>
<tr>
<td>Veneer Sheets</td>
<td>1915</td>
<td>20.33</td>
<td>72.12</td>
<td>0</td>
<td>959</td>
</tr>
<tr>
<td>Sawn Wood</td>
<td>1877</td>
<td>254.17</td>
<td>666.97</td>
<td>0</td>
<td>5490.20</td>
</tr>
</tbody>
</table>
4. Empirical Modeling

The field of environmental treaty evaluation is fairly new and without strong precedents. The first study, conducted by Murdoch, Sandler, and Sargant (1997) utilizes maximum-likelihood analysis to evaluate the Helsinki and Sofia United Nation Protocols. The econometric methodology used in treaty evaluation research since then has been incredibly varied. There have been two cases of Difference-in-Difference (see: Aakvik and Tjotta 2010; Bratberg, Tjotta and Oines 2005), as well as two studies that utilize Ordinary Least Squares (see Lagring 2012; Ringquist and Kostadinova 2005). Empirical evaluation of the full literature on environmental agreement effectiveness shows little consistency in methodology or variables (Houghton and Naughton, 2013).

The goal of this study is to find the causal effect of treaty membership on the timber export categories targeted within the ITTAs. The structure of the ITTAs is such that countries are free to enter and exit at any point. This freedom in starting period makes it easier to identify the individual effect of the ITTA separate from worldwide yearly changes in culture and timber demand. In the Difference-in-Difference examples from previous literature, Aakvik and Tjotta (2010) in particular, this is not the case. The estimation model in that paper is regarded as the best way to model the adoption of a treaty by many countries in the same year.

In order to find the extent to which membership in the ITTAs explain the export trends of member tropical nations this study utilizes a fixed effects model. This model controls for unobserved heterogeneity across the sample countries as well as the included variables of market potential, population, GDP per capita and the squared form of GDP per capita. Additionally, the fixed effects model should account for the measurement error that is likely to occur when
working with export data for a forty-year period. The estimation, including ITTA and these additional explanatory measures, contains the following variables:

- \( \text{Exports}_{it} \): the logarithm of agreement-targeted timber exports in country \( i \) for year \( t \),
- \( 1983 \text{ ITTA}_{it} \): dummy for membership in the 1983 ITTA by country \( i \) for year \( t \),
- \( 1994 \text{ ITTA}_{it} \): dummy for membership in the 1994 ITTA by country \( i \) for year \( t \),
- \( \text{MPot}_{it} \): market potential as a function of geographic distance and GDP per capita of surrounding nations,
- \( \text{Population}_{it} \): the population of country \( i \) for year \( t \),
- \( \text{GDPC}_{it} \): the measure of GDP per capita in country \( i \) for year \( t \),
- \( \text{GDPC}_{it}^2 \): the quadratic measure of GDP per capita in country \( i \) for year \( t \), and
- \( Z_{it} \): a vector of country specific fixed effects.

The agreement-targeted timber exports level for country \( i \) in year \( t=1980, 1981, \ldots, 2011 \) is:

\[
\text{Exports}_{it} = \beta_0 + \beta_1 1983 \text{ ITTA}_{it} + \beta_2 1994 \text{ ITTA}_{it} + \beta_3 \text{MPot}_{it} + \beta_4 \text{Population}_{it} + \beta_5 \text{GDPC}_{it} + \beta_6 \text{GDPC}_{it}^2 + Z_{it} + \epsilon_{it},
\]

where \( \epsilon_{it} \) is the error term for country \( i \) in year \( t \).

If the ITTAs have been successful, the 1983 ITTA and 1994 ITTA are preceded by negative coefficients, indicating that membership in the agreements leads to a lowered level of agreement-targeted exports. The variable MPot is the distance-weighted sum of other countries accounting for the nearness of potential foreign consumers. MPot ought to have a positive effect on exports, since the larger and closer the market for timber exports is, the more inclined a nation would usually be to produce timber. Theory suggests that the Population coefficient will be positive, showing increased population is correlated with higher levels of timber exports as a result of larger industry. The expected coefficient for GDPC is positive and negative for GDPC\(^2\), forming a “cave-shaped” function following the environmental Kuznets curve (Stern 2004). This model explains environmental valuation as a luxury good that becomes important as a nation’s citizens accrue substantial wealth, but decreases in the development stages of an industrial economy. Both GDPC variables are generated using the population and GDP data described earlier.

5. Empirical Results

5.1 Main Results

The findings from this study are conflicted regarding the effectiveness of the ITTAs. The study estimates a baseline model of the impact of the 1983 ITTA and 1994 ITTA on a timber
aggregate of all targeted timber export categories. In addition, each targeted timber category is individually examined. The specific coefficient results from the regressions are provided in Table 2 below. All coefficients interpreted within this section are statistically significant above the 10% level.

Participation in the 1994 ITTA is associated with a substantial decrease in timber exports for the time period evaluated, when all export categories are aggregated. For the individual categories, membership in this ITTA is associated with an increase in exports in all timber categories but “Logs”. For “Logs”, membership in the 1994 ITTA is associated with a decrease in exports. The results for the 1983 ITTA follow a similar pattern, although the coefficient for the ITTA effect for the aggregate exports is not significant. Again, membership in the ITTA is associated with an increase in exports for the individual categories, except for the “Logs” category. This may indicate that ITTA participation causes producer countries to shift away from raw material exports toward those that provide additional income via the labor provided in processing the logs.

These coefficient results contradict the expected effect of treaty participation for each category except for logs, which shows a decrease for both ITTAs, although much more substantially the 1994 ITTA. In order to understand why the aggregate estimation indicates a strong decrease in timber exports for the 1994 ITTA, while only exports of logs shows a decrease, Table 1 shows that for the available observations the quantity of logs exported greatly outnumbers exports in the other three categories. As noted in the methods section, the timber aggregate variable is created through a simple summation of all four export categories for each country by year. As such, it follows that the large impact of the 1994 ITTA on the exports of logs would overwhelm the effect of the ITTA on the other categories when aggregated.

The findings for the effect of ITTA participation complicate the analysis generated in previous research. Johnson (1985), Jacobson and Weiss (1995), Wilson (1996), and Flejzor (2005) all express doubt regarding the effectiveness of the first agreement, although none suggest the potential for agreement participation to increase forest product exports for targeted categories. These studies also believe that the 1994 ITTA would not be effective at reducing deforestation, while the estimated general model in this study does in fact show a decrease in exports. The abovementioned studies do not use data to evaluate the ITTAs, however, so there is not cohesion regarding the use of exports as a proxy for deforestation.
The findings from the model estimation partially agree with the lone quantitative study performed by Chirchi (2004). Chirchi finds that the agreements overall had been effective, but does not evaluate the separate effects of the agreements. For the aggregate timber regression, which is most similar to Chirchi’s model, the results match for the 1994 ITTA and are inconclusive for the 1983 ITTA.

The market potential coefficient is negative, which does not match the expected relationship. This could indicate the presence of omitted variable bias, or could suggest that tropical countries with increased market potential choose to exports goods other than timber. An increase in population is associated with a slight increase in timber exports for all categories. This supports theory, although the effect is not as large as expected, as a thousand person increase in population is associated with only a 13 cubic meter increase in timber exports.

The estimates of the covariates GDP per capita and GDP per capita-squared form a u-shaped function when combined. For the time period estimated in this model, this relationship between timber exports and GDP per capita indicates that increased citizen wealth is associated with lowered timber exports at first and then higher exports as GDP per capita grows. This does not support the theory of the environmental Kuznets curve, but the model is focusing on the years 1970-2011 in particular and not on cross-sectional variation that typically drives the EKC relationship. Additionally, the Kuznets curve theory is supported by the results from the “Plywood”, “Veneer Sheets”, and “Sawn Wood” categories.

The total timber exports model explains 17 percent of variation of timber exports in the sample. Although this is a lower R-squared than typical in many fields, it is in the acceptable range for environmental treaty effectiveness literature. The lowest R-squared for the individual timber export categories is .043 for “Sawn Wood”, while the estimation of “Plywood” explains 26.3 percent of variation in the model for the time period. While the panel is unbalanced, the missing data points seem to be random throughout the dataset and uncorrelated with the error term. Additionally, the Hausman test indicates that the fixed effects model is appropriate over a random effects model.
Table 2

<table>
<thead>
<tr>
<th></th>
<th>Timber Aggregate</th>
<th>Plywood</th>
<th>Veneer Sheets</th>
<th>Sawn Wood</th>
<th>Logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983 ITTA</td>
<td>-463.1645</td>
<td>261.38***</td>
<td>11.69***</td>
<td>98.46***</td>
<td>-1,415***</td>
</tr>
<tr>
<td></td>
<td>(489.29)</td>
<td>(53.93)</td>
<td>(3.78)</td>
<td>(37.3)</td>
<td>(538.5)</td>
</tr>
<tr>
<td>1994 ITTA</td>
<td>-2028.67***</td>
<td>275.12***</td>
<td>20.04***</td>
<td>107.6***</td>
<td>-3,126***</td>
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<tr>
<td></td>
<td>(456.0948)</td>
<td>(54.30)</td>
<td>(4.003)</td>
<td>(35.56)</td>
<td>(496.6)</td>
</tr>
<tr>
<td>Market Potential</td>
<td>-111.04</td>
<td>-18.41</td>
<td>-1.018</td>
<td>20.64***</td>
<td>-119.8</td>
</tr>
<tr>
<td></td>
<td>(97.90)</td>
<td>(12.05)</td>
<td>(0.932)</td>
<td>(6.998)</td>
<td>(107.7)</td>
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<tr>
<td>Population</td>
<td>0.013***</td>
<td>0.0034***</td>
<td>0.00095***</td>
<td>0.00094***</td>
<td>0.00896***</td>
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<tr>
<td></td>
<td>(0.0020)</td>
<td>(0.0037)</td>
<td>(2.59E-05)</td>
<td>(0.0022)</td>
<td>(0.00211)</td>
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<tr>
<td>GDP per capita</td>
<td>-0.6066***</td>
<td>0.144***</td>
<td>0.0025**</td>
<td>0.0107</td>
<td>-1.148***</td>
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<tr>
<td></td>
<td>(0.158)</td>
<td>(0.019)</td>
<td>(0.000932)</td>
<td>(0.011)</td>
<td>(0.179)</td>
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<td>GDP per capita²</td>
<td>1.27e-08***</td>
<td>-2.90e-09***</td>
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<td>(66.55)</td>
<td>(4.2841)</td>
<td>(40.93)</td>
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<tr>
<td>N</td>
<td>370</td>
<td>2,203</td>
<td>1,915</td>
<td>1,877</td>
<td>415</td>
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<tr>
<td>R²</td>
<td>0.17</td>
<td>0.116</td>
<td>0.043</td>
<td>0.053</td>
<td>0.263</td>
</tr>
</tbody>
</table>

Significance level of two-tailed test at * 10%, ** 5%, and ***1%.

6. Concluding Remarks
The International Tropical Timber Organization created the 1983 ITTA in order to slow deforestation in tropical countries and to promote sustainability. This agreement was followed up by additional ITTAs in 1994 and 2006. Despite these efforts, deforestation in tropical countries has continued, threatening species diversity and affecting climate change by way of greenhouse gas emission. This study empirically evaluates the effectiveness of the 1983 and 1994 ITTAs with respect to compliance from tropical nations. The findings show inconclusive results for the 1983 ITTA, but that the 1994 ITTA was effective overall.
It is important to note that effectiveness, in this study, is defined as member nations’ compliance with the terms of the ITTAs. The analysis of timber exports is limited to only those timber goods specifically mentioned in the ITTA documents themselves. Within these individual categories, the 1994 ITTA was effective only for the “logs” category. This could be disheartening, however, the log exports account for a full seventy percent of targeted timber category exports for the time period evaluated. Timber literature should be consulted to better understand the contrast in these categories. Additionally, the difference in effect of the 1983 ITTA and the 1994 ITTA is puzzling. Further research could seek the differences between these, as well as account for additional explanatory variables. Perhaps technological developments in the timber industry made it easier for countries to export lumber as non-ITTA-specified categories during the duration of the 1994 ITTA. Another explanation could be that the seriousness with which countries took ITTA participation increased over time, affecting the compliance for the 1983 ITTA versus the 1994 ITTA.

While the creation and continued presence of the ITTAs have been touted by politicians as successful steps in environmental protection, little empirical work has been conducted to support those claims. The findings in this study suggest that while there has been a measure of success, there is still more work to be done. Overall, there should be significantly more research into the terms of the ITTAs and the impact of their implementation.
7. References


