Relationship Between GDP Growth and Deforestation in the Central American and Caribbean Countries with Further Analysis on the Major GDP Earning Industries Among These Countries and Their Contribution to Deforestation

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CHANG, Chia-Wei

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Abstract

Latin America and the Caribbean experiences most serious deforestation trend in the world. There is a total decrease of 970,000 square kilometers of forest area between 1990 and 2015 in the region, which translates to 10% loss in the original forest coverage. Conventionally, economists had based their study on the entire Latin America. However, this research paper will focus only on Central America and the Caribbean for that they demonstrate distinctive features that are different form the South American countries. The research attempts to identify how economic development can affect the forest coverage in Central American and Caribbean countries. It further argues that economic development will cause higher burden on the supply of natural resources and results in the decline of forest coverage. The econometrics model evaluates the contribution to deforestation from the major GDP earner industries, such as tourism and agriculture. It also considers other development factors like forest burned, population growth and urbanization into the model. Finally, this paper provides results that can lead to feasible policy recommendations that can assist the region in conserving its natural resources for future growth and developments.

Table of Content

I. Introduction

On the International Day of the Forests, the World Bank had released new satellite data and revealed a shocking fact that Latin America and the Caribbean experience most serious deforestation trend in the world with a total decrease of 970,000 square kilometers of forest area between 1990 and 2015. On average, the region had already lost 10% of its original forest coverage while being the home to one quarter the of the world's forest resources (Khokhar and Tabary, 2016). The region had raised environmental concern to the international organizations for the sustainability of the economic development activities that are currently carried out. The Directorate-General of Environment for European Commission explicitly listed several economic development goals of the region such as agriculture expansion, infrastructure development and market growth as the direct and indirect drivers of deforestation in Latin America (2010). In addition, the most recent studies conducted by Cuaresma and his fellow researchers have argued that, on the global scale, marginal effect of economic growth on forest cover is strongest in developing economies (2016). Latin American region is therefore prone to strong effects for it being among the newly developing economies.

Conventionally, economists had based their study on the entire of Latin America (Southgate & Runge, 1990 & Leisher et al, 2013). However, this research paper will focus on only Central America and the Caribbean (hereafter refer to as CAC) for that they demonstrate distinctive features compare to the South American countries. Comparatively, Central American and the Caribbean countries are relatively smaller in country size and less populated. Moreover, South America is abundant with diverse landscape with large volume of forest coverage on the ground, the forest area is around 120,000 to 5,000,000 kilometer square. On the other hand, all countries (except Mexico) in the Central America and the Caribbean do not have forest area larger than 50,000 kilometer square (Kirk, 2016). The depletion rate of forest and the effects on landscape are therefore very hard to generalize between the two regions without proper separate study.

The purpose of this research is to identify how economic development can affect the forest coverage in CAC countries. It builds on the existing research (Dourojeanni, 1999 & Pare´s-Ramos, 2008) by providing additional empirical arguments regarding the environmental challenges of terrestrial resources in the region. This research argues that economic development will cause higher burden on the supply of natural resources and results in the decline of forest coverage. It further evaluates the contribution to deforestation from the major GDP earner industries, such as tourism and agriculture while including other factors into the econometrics model. The findings of this research are of interest to policy makers, NGOs and environmentalists in the CAC. In addition, this research can be useful for economists as it can serve as external validity check for the theories and results that were generated in previous studies. It will also assert the importance of adequate economic development policies to minimize the depletion of natural resources during the course of development.

This research attempts to answer the following questions through quantitative analysis: 1) How does economic performance affect forest coverage in Central American and the Caribbean countries? 2) How much the major industries in this region contribute to deforestation? This paper will first cover a thorough review on the existing literature on the effect of economic development on the forest coverage. Then, empirical strategy will be described and explained in detail with the provision of functional equation involving all factors of consideration. The result of the panel data analysis will then be presented in table forms. Interpretations on significant results will also be included. Finally, the last section of this research paper will indicate the issues and implications of the current economic development activities and how it can be improved to avoid further deforestation in the region.

II. Literature Review

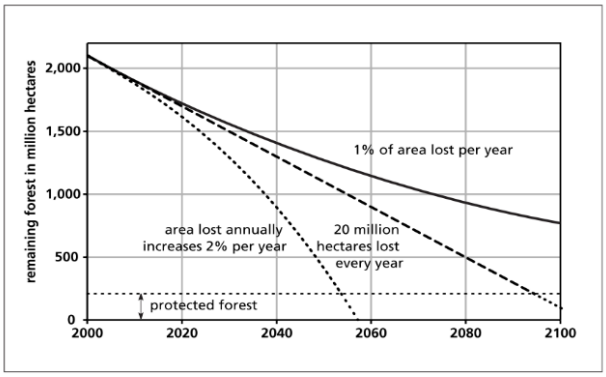
This section provides an overview of the existing theory on deforestation and the empirical arguments on deforestation trend, specifically on the Latin America and the Caribbean. This paper revisits the research conducted on forest resources and examines its relationship with economic development activities. It later focuses on presenting potential causes of deforestation in the stated region.

The term deforestation cannot be properly defined without clarifying the concept of "forest". A study conducted by Lund has found that there are more than 800 different definitions of "forest" that are used around the world (2008). In order to ensure the coherent standard for research and monitoring purposes, the Food and Agriculture Organization of the United Nations had released the common criteria for forest in the Global Forest Resource Assessment marking that forests should have a "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" (2010). This provides a common measure for the calculation of forest coverage among countries. It thus aligns the data specification in international organization database such as World Bank and FAO. At the same time, it corrects the measurement discrepancies that are involved in research. The term deforestation, therefore, suggests the clearing of existing specified forest or the conversion of those areas into other land use (FAO, 2015).

II-A. Relationship between deforestation and economic development

Although in the recent decade the issue of deforestation became a hot environmental topics of the mass media, the over harvesting of lumber is not a recent problem. Extraction of ecological resources has always been the foundation of economic development in the human history. Developing countries also have been experiencing serious a trade-off between the environment and economic growth since their early stage of development. Such issue was

officially addressed in the United Nations Conference on the Human Environment in 1972 (Combes Motel, 2014). It is again brought up in a UN commission report stating that developing countries with high economic growth usually extract raw materials from forest and sea for subsistence activities thereby costing significant impact on their biosphere (Brundtland, 1987).



Another argument states that the geographical and infrastructural factors that promote economic development also pushes deforestation to increase (Grimm, 2009). Although the underlying reasons of deforestation due to economic growth might differ, faster economic growth accompanied by accelerating rate of deforestation is observed within many countries around the world, Australia (Braithwaite, 1996), India (Haeuber, 1993) and Democratic Republic of Congo (Megevand et al, 2013), just to name a few.

The forest in tropical belt (Latin America and the Caribbean, parts of Africa and Southeast Asia) receives more attention from researchers and monitoring effort. It is so not only because tropical forests are a rich source of biodiversity, they also facilitate access to the modern development and trade through regular supply of abundant natural foods (Rainforest Alliance, 2012). The study on the tropics thus became crucial in understanding the nature of development and its relation with deforestation. Various research on tropical forest for the industrialization period arrived to similar result as the world's trend—that is, the economic development activities in tropical countries hamper the forest sustainability in the region in the long run (VanSoest, 1998, pg. 62 & Dourojeanni, 1999). Further study suggested that the tropical forest will completely disappear as early as the 2060s if no policy adjustment and

properly management of human activities in development are carried out (Meadow et al, 2006). Although the actual reality of the tropical forest in the future might be different from the ones projected, scholars have shared a consensus that development incentives with support of booming economies poses significant threats to forest in the Latin America (Lambin et al, 2001 & Pare´s-Ramos, 2008). Some scholarships also actively proposed the reverse growth-environment relation commenting that environment can influence economic growth in the long run (Barbier, 1999 & Xepapadeas, 2005). Nevertheless, the trade-off between economic development and deforestation appears to be destined.

II-B. Proposed causes of deforestation

Conventionally, agriculture is considered as the main culprit of deforestation. For the Philippines' tropical forest, researcher named agricultural land expansion as the one of the main attributes to the decline of forest coverage (Kummer 1992). Studies in the later years also had reached to similar result pointing out that large scale expansion of agricultural plantations for commercial purposes pushes forest to diminish (Kaimowitz et al, 1996 & FAO 2015). On top of the existing agricultural industry, the cattle farming business is expanding fast and strong in developing countries for the increasing demand of meat product. Growth of commercial opportunities in cattle ranching worsen the situation of forest clearing through pasture expansion (Weaver, 1999 & Tole, 1998). This is especially true in the Latin American countries (Culas, 2009). The heavy reliance on agricultural outputs for revenue generation and GDP growth had made the Latin America region difficult to move away from the vicious negative consequences of economic growth on the cost of primary forest lands.

Tourism sector has also started to become the development focus in CAC countries in the recent years. Countries had realized that the exploitation of resources can move beyond simply extracting them for sale. In the region, Belize, Costa Rica, and Trinidad and Tobago, among others, are all experiencing high growth in tourism and the industry had demonstrated strong force in fueling the overall country's economy (Oxford Business Group, 2016 & The San

Pedro Sun, 2017 & The Tico Times, 2016). Tourism activities, in general, are viewed to be more environmental friendly, especially many countries heavily advertise their natural tours as ecotourism. The growth of tourism industry thus claim to bring positive externalities to the society. Calvo-Alvarado et al supported this theory stating that tourism, as a rising industry, allows for alternative employment and income to agriculture. Additionally, its development shoots up the price of land, therefore fewer clearing will be made for agricultural purposes (2009). However, several research had made persuasive opposition to fast growing tourism industries. It is suggested that without proper measures and good governance, tourism "is bound to have negative environmental and socio-cultural impact on communities" (Neto, 2003). Nunkoo and Ramkissoon supported this theory in their research naming that rapid tourism development has worsen traffic congestion, increased cost of living and pollution in the local areas (2010).

II-C. Aftermath of deforestation

A sustainable and intact forest system yields many environmental implications. Apart from the obvious functions like absorbing carbon dioxide and regenerate oxygen, forest is also the home to millions of wildlife on the planet. It allows the maintenance of biological balance in the animal kingdom. The tropical area in Latin America and the Caribbean, in particular, consider to have the largest holding of wildlife and plantations on Earth. The depletion of forest cover in the region can induce environmental danger to the local residency via soil erosion and breakdown of biological chain and further contribute to the existing world climate change. Latest geophysical research on satellite data provide grounds for this claim stating that the deforestation in the tropics has the most significant impact on global warming (Schultz et al, 2017).

Deforestation raises far more than just environmental concerns. The environmental threats triggered by deforestation could have a severe impact on food security and supply, especially in countries that heavily rely on agricultural sectors and are sensitive to

temperature and rainfall changes. This can create additional difficulty on implementing poverty alleviation strategies in those countries (Combes Motel et al, 2014). In addition, deforestation alters the natural landscape and creates ecological disturbances. Emergence of zoonotic diseases, such as Ebola, MERS and SARS are stressed by environmental changes and seriously threatens the maintenance of public health and medical system. These zoonoses had made the world suffered from fear of outbreaks and countless innocent lives. The costs in combating these diseases have also exceed US$100 billion in the last decade (UNEP, 2016).

III. Empirical Strategy and Data

III-A. Identification Strategy

For the purpose of identifying the relationship between deforestation and the economic and industry development in the CAC region, 12 countries from the CAC region are included in the sample pool for analysis. Due to data availability, this paper only focuses on the data of 1995-2014. Instead of using the country data from each nation, the panel data of this paper is gathered through World Bank Development Indicator Database and Food and Agriculture Organization (FAO) for the purpose of ensuring data completion and coherent measurement across countries in the studied region. 20 years of data is used for a proper evaluation of the trend of changes in terms of different production output and environmental indicators, aiming to shape the big picture of the regional development. In addition, such a time span of data is necessary in order to yield an accurate result on the analysis since deforestation (or reforestation) is a slow process and is usually back legged for a few years to reflect its real economic activities.

Utilizing this country level panel data, linear model with country fixed effect is the main estimation strategy. Fixed effect is particularly crucial in this model because when doing the country level comparison on deforestation, the countries studied may possess unobservable characteristics that might different from one and another. Therefore, it's is important to take out the effects of the time-invariant characteristics from the regression model itself. In addition, important control variables are introduced to reduce omitted variable bias and endogeneity issue. Therefore, the main model for the analysis can be explained as:

$$Y_{it} = \alpha_0 + \beta_1 GDP_{it} + \beta_2 Production_{it} + \beta_3 Tourist_{it} + \beta_4 Roundwood_{it} + Z'\gamma + \mu$$

where the outcome variable Y represents forest coverage of the country. The four main variables of concerns are: GDP per capita, livestock meat production, tourist arrival and roundwood production, each representing country level economic performance, livestock

industry, tourism industry and forestry industry. The Z is a representation of vectors of control variables that are included in the model, which are population, growth in urbanization and area of forest burned. Apart from the dependent variable (forest coverage) and one control variable (organizational growth), the rest of the variables are in its own measurement with large number. It's then necessary to take log of these figures to ensure a normal distribution of the data.

Conventionally, Latin America and the Caribbean are grouped as one region for their similar characteristics. For the purpose of testing for sample specification and ensure the result of the fixed effect is valid, the data set is expanded into 440 observations by adding in 10 more South American countries. In addition, in order to keep the CAC's own identity from the bigger picture, interaction terms are added into the equation to make sure the impact of variables in the CAC can be observed separately. The same strategy is used on this new larger data set. The OLS results, fixed effect results and the regressions with interaction terms will be presented for comparison.

III-B. Data definition

Table 1: Descriptive Statistics of 12 CAC countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Forest Coverage	240	40.8513	15.24256	13.0019	67.41166
GDP per capita	228	3836.077	2269.403	699.51	11786.63
Tourist arrival	240	3005328	5745539	131000	2.93E+07
Livestock meat production	240	337052.1	634478.2	7088	2919847
Roundwood Production	240	1.14E+07	2.57E+07	7525	2.56E+08
Population	240	1.79E+07	2.99E+07	206962	1.25E+08
Urbanization Growth	240	2.183785	1.002678	0.17667	4.135885
Forest area burned	240	159585.8	344184.7	0	1888963

Table 2: Descriptive Statistics of 10 South American countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Forest Coverage	200	45.36581	23.05436	6.19215	84.53645
GDP per capita	190	4978.955	3750.105	855.416	16881.38
Tourist arrival	200	1707990	1611218	66000	6430000
Livestock meat production	200	1222956	2594684	7318	1.30E+07
Roundwood Production	200	3.35E+07	6.85E+07	1165008	2.67E+08
Population	200	3.27E+07	5.27E+07	726695	2.06E+08
Urbanization Growth	200	1.628757	0.824377	-0.382	3.570785
Forest area burned	200	1636938	3449852	0	2.21E+07

Forest coverage. World Bank data set is utilized as it provides a measure that corresponds with the UN standard. Only the areas that cover with trees of at least 5 meters on natural or planted stands are counted as forest area. The trees in urban parks, garden and other agricultural production plants are excluded from the count. In addition, the data collection did not take into account on the productivity of the trees. The actual functionality of the particular tree species or individuals to the entire ecosystem are not part of the consideration when measuring the forest area. Forest coverage is then shown in percentage as forest area to the total land area of each country. The mean forest coverage for the CAC region from 1995 to 2014 is 41% while the South American countries have an average of 45% forest coverage for the same time period.

***GDP per capita*.** This serves as the main variable of concern for that it represents the overall economic performance of a country in an annual year. The data is retrieved from FAOSTAT Macro indicator. This data is a reproduction of the figure from United Nation Statistical Division (UNSD) with adjustment towards annual population changes across time. The data comes with a good quality of accuracy and coherence as it was collected through standard annual National Accounts Questionnaire that the UN member states and other territories will have to submit, although estimates are often used for incomplete or inconsistent information. The GDP per capita is presented in current US dollar for the

suggested annual year. The mean GDP per capita is 3,836 USD for CAC region having Panama as the best economic performer among all with an average of 6,026 USD, almost 1.5 more than the regional average. South America has comparatively much higher GDP per capita with regional average of 4,979 USD. Uruguay comes with best economic performance throughout the 20 years with an average GDP per capita of 8,613 USD. This figure is almost half times more than the average of the best performer in CAC.

Tourist arrival. International overnight visitors make head counts on the tourists who travel to a foreign country not of their residence. Only the tourist of whom their main purpose of arrival is visiting rather than other events that starts from the country visited are counted. Although the data collection method on tourist arrivals usually differ between countries, the World Bank holds a data set that has a relatively comparable data for cross-nation analysis. The data is mainly from the World Tourism Organization, Yearbook of Tourism Statistics and Compendium of Tourism Statistics. These three sources are all guided by the UN World Tourism Organization (UNWTO) Methodological notes which periodically collect the official data from the governments or the authorized tourism administration agencies in each country through a questionnaire form. Discrepancies in the primary data collection in local government level might pose an incomparable issue for this measurement. However, UNWTO had provided International Recommendations for Tourism Statistics in 2008 in order to help aligning the measurement standard for the industry. The data before and after 2008 had also went through validity and homogeneity checks to ensure the historical trend and series presented are reasonable and accountable. In the CAC region, the mean tourist arrival number is 3,005,328 while South America has an average of 1,707,990. This unexpected gap is mainly due to the outlier in the two regions. Mexico and Guyana respectively represent the outlier of the upper bound of tourist arrival during this 20 year period and the outlier of the lower bound of the tourist arrival distribution.

Meat production. Livestock farming is one of the fast growing industries in the CAC due to the increasing global demand on meat. The livestock production, more specifically the

meat produced directly from the livestock raised is therefore used as a variable of concern to understand the effect of livestock farming to the deforestation. Beef and poultry are largely sourced from the Latin America and the Caribbean as the region supports 23% and 21.4% of the production respectively for the world market (FAO). The data of the meat production is thus focused on cattle and chicken only. FAO data is utilized instead of other sources not only for that these figures come from government official data, but the missing data are also substituted with estimates calculated through learning algorithms that receive resources from national or international agencies. In the South America, the mean meat production during 1995-2014 can is around 1.2 million tons while the CAC regional average production is only around 0.3 million tones. There's also a great difference in terms of production level within the CAC region due to the limitation in land resources. Guatemala and Nicaragua are comparatively much bigger than other countries in the region and surely produce more than average.

Roundwood production. In the forest industry context, the most adequate measure of removal of trees from the forested area would be roundwood production. Roundwood represents the quantities of all the woods that are extracted from the forested area and other woodland prior to its further processing into by-products such as wood fuel and paper. This measure is more of a measure of interest in the CAC region for that in the developing countries roundwood are usually exported to foreign lands for value-added processing. The average roundwood production for South America is around 33 million square meters. The mean level of production in CAC is almost one third as of South America, with around 11 million square meters in average over the 20 years of time. The production level within CAC region also varies greatly among member countries. Once again, this is limited by the available resources on the land that are closely related to the size of the landscape.

IV. Main result

IV-A. Basic Result

Table 3: OLS and Fixed Effect Regressions

	Forest Coverage			
	OLS		Fixed Effect	
	(1)	(2)	(3)	(4)
logGDP	16.047***	14.693***	3.682	5.688**
	(1.486)	(1.310)	(2.468)	(2.177)
logproduction	6.676***	6.562***	-5.596***	-4.004***
	(0.966)	(1.062)	(1.358)	(1.200)
logtourist	-16.042***	-9.966***	-1.804	-1.885*
	(1.165)	(1.020)	(1.413)	(0.868)
logroundwood	0.788	-1.244***	0.179	0.061
	(0.568)	(0.476)	(0.165)	(0.123)
logpopu		-6.673***		-15.933**
		(1.176)		(6.050)
logburn		3.428***		-0.180
		(0.371)		(0.234)
Urban Growth		5.292***		-0.573
		(0.607)		(1.204)

Standard errors in parentheses

="* p<0.1 ** p<0.05 *** p<0.01"

From table 3, in the simple OLS regressions, the four variables of interest seem to be showing significant results. It would appear that with the increase in GDP per capita and livestock meat production can have relatively large and positive effect on the forest coverage. However, after controlling for the unobserved but time invariant characteristics among countries using fixed effect method, it is observed that GDP per capital, livestock meat production and population show to have a significant result under the 95% confidence level.

For every 1% of increase in GDP per capita, the forest coverage of the countries in Central America and the Caribbean will increase by 5.69%. Such result is not unprecedented, but rather evidential in many European and Asian countries. It is shown that the country experiences trade-off between economic performance and the environment until it reaches to the turning point of the Kuznets curve where economic outcome is relatively strong and satisfying. After the turning point, the awareness for environmental concerns raises and therefore promotes better environmental policies and further reduces deforestation.

Nonetheless, the result does not necessarily represent that the CAC countries stand in a good economic position to be environmentally friendly. Instead, the reason behind this positive coefficient perhaps lies in the tourism propaganda of the governments of the region and its cultural heritage. CAC is well known for its eco-tourism in natural landscape and untouched wilderness to attract foreign visitors. Unlike many parts of the world, CAC countries (except Mexico) are relatively small in size and the resources are fairly limited for exploration and harvest. The steady income of tourism made the environmental protection scheme became a continuous priority to all governments in power to secure and maintain their attraction sites. Politically and economically speaking, the country would be putting far too much at risk if the environment is not protected. To the governments of the region, with better economic performance, more money can be injected into environmental protection and improve the current deforestation trend. This can be considered an indirect investment to the tourism industry.

Moreover, from the data analysis, it is observed that the increase of livestock meat production can have a negative impact on the forest coverage. With an increase of 1% of meat production in beef and poultry, the forest coverage will decrease by 4%. This result well demonstrated the threats that livestock farming is posing to the habitat maintenance in the CAC region. Although strategies were developed to enhance the productivity and efficiency of livestock farming in some developed countries, the farming techniques utilized in the CAC is still considerably traditional using simple pasture feeding. Therefore, the increase of meat

production directly translates to the increase in the scale of livestock farming and pasture expansion. The recent trend of growing reliance on livestock farming for economic gain had made CAC region prone to higher environmental degradation. Studies based on satellite data had shown that in Colombia, pastureland has extended to the forested area and caused serious deforestation. Similar situation occurred in Nicaragua and Guatemala where there's an expansion of cropland into pasturelands while pastures were significantly extended into forests (Grasser et al, 2015).

IV-B. Analysis with interaction terms

Table 4: Effect of GDP per capita on forest coverage

	Dependent Variable: Forest Coverage		
	(1)	(2)	(3)
	OLS (fixed effects)	OLS (fixed effects)	Interaction terms
logGDP	3.682	5.688**	-0.452
	(2.468)	(2.177)	(0.749)
CAC countries* logGDP			6.441**
			(2.271)
logproduction	-5.596***	-4.004***	1.107
	(1.358)	(1.200)	(1.313)
CAC countries* logproduction			-4.796**
			(1.565)
logtourist	-1.804	-1.885*	0.422
	(1.413)	(0.868)	(0.618)
CAC countries* logtourist			-2.096
			(1.083)
logroundwood	0.179	0.061	0.041
	(0.165)	(0.123)	(0.171)
logpopu		-15.933**	-17.074**
		(6.050)	(5.373)
logburn		-0.180	-0.051
		(0.234)	(0.130)
Urban Growth		-0.573	-0.037
		(1.204)	(0.916)
N	240	239	437
Standard errors in parentheses			
="* p<0.1	** p<0.05	*** p<0.01"	

From table 4 column 3, the sample data had expanded while having additional interaction terms in the regression. In general, it can be seen that none of the variables appear to be significant in the entire Latin America and the Caribbean context, except population growth. This indicates that in general, the changes in industry and country economic

performance to deforestation issues are different between the CAC region and the South American countries. Furthermore, the interaction terms that represents the CAC region not only are significant but consistent with the results reached through previous smaller sample data.

From looking at the GDP per capita variable, the coefficient of the interaction terms that represents the CAC region is positively higher than the previous fixed effect regression. Economic development in the CAC countries creates substantial support to environmental protection in the local communities. However, South America has a higher GDP per capita than CAC region to begin with. Their economic development is also strongly supported by more diverse industries and complex trading in commodities. Peru, Guyana and Uruguay are the ones that are mainly generating revenue through agriculture and mineral exports. Countries such as Venezuela, Brazil and Argentina have an economic composition of oil, agriculture and mining industries (WITS, 2017). The major revenue earners in South America are mainly industries that extract natural resources from the environment and invasive activities for the nature. This is fundamentally different from the CAC countries where they have limited land and natural resources to consume, nor to say to put aside the sustainability issue. Although the fact that South American countries are experiencing one of the largest loss in rain forest in the world throughout the years, the relationship between such deforestation and the improvement of economic performance cannot be easily established for their complexity in its economy and lack of urgency in considering about sustainable development.

From table 4, no significant relationship can be established between the livestock meat production indicator and deforestation in the whole Latin America context. However, the positive coefficient is still interesting to discuss, which is completely opposite from the result of the CAC region. The main reasons behind such difference can be viewed in two aspects: soil fertility and government initiated supporting program. CAC countries mainly follow traditional livestock farming techniques while the soil fertility is low to grow nutritious

pastures. Therefore ranching is inefficient by having pastures that provide a diminishing support to the grazing activities of the livestock (Butler, 2012). The situation is fairly different in South America. South America consists of large portion of rain forests that are equipped fertile soils of mixture of volcanic and floodplain soils (Butler, 2012). The productivity of livestock farming is relatively high. Despite the fact that there's still a continuous increase of forest clearing for ranching, the necessary lands for livestock farming is a lot less than of CAC. The actual difference in land usage is much more apparent in the long run.

In addition, many governments of South American countries have been promoting agribusiness and productivity enhancement programs for the livestock sector. Substantial injection of advance technology and capital supports into the sector had made ranching intensification possible without further extension on the forest lands (Echinique, 2011). Argentina and Brazil had followed the U.S in practicing feedlot production system whereby cattle and livestock are fed by crops or biofuel by-products to increase meat produced from limited heads of cattle with less space (Borras et al, 2012). The land sparing policies in Brazil is especially outstanding in preventing both legal and illegal deforestation by providing subsidies to forest owners in keeping the forest areas intact (Nepstad et al, 2013). This kind of supporting system and subsidy/commodity programs are not available in the majority of the CAC countries due to lack of financial funds. The environment of CAC region thus became much more vulnerable to the meat production from livestock farming than its neighbors in the South America.

Population is another important factor that is of matter of concern. The reason behind this result is also logical in both CAC context and looking at LAC as a whole. However, the degree of impact of population growth is quite high compare to other variables in the regression. For LAC in general, if the population grow by one percent, the forest coverage will reduce by around seventeen percent. If its' a CAC country, one percent point of increase in population could lead to a decrease in forest cover by almost 16%. These figures are extremely large to be ignored as the average forest coverage in the CAC and South America

is only around 40% and 45% respectively. Population growth then seems to be the main threat that can trigger an unrecoverable yet near instant negative impact to the forest protection effort in the region. However, the potential correlation between population growth and other industrial development indicators, such as agriculture, housing and urbanization are the key to explain such large coefficient.

It is suggested by Meyerson that in the countries, such as the ones in the Latin American regions that have high agriculturally based households, the increase in populations density can directly lead to the clearing of the forest for subsistence farming (2013). The clearing can get especially drastic if the agricultural production per hectare is lower mainly due to infertile soils and lack of advance farming techniques. Apart from this, the population demographics also play a crucial role in the potential change of forest distribution. Fertility studies had shown that high birth rate occurs in remote frontier environment and rural areas (Sutherland et al, 2004). This suggests that the population growth is highly likely to be in forested environment where the clearing of forest line would be inevitable in order to house the growing residence. In this sense, the rural areas have an incentive to urbanize their location of residence with higher degree of development and even connect the area to the outside cities through road construction.

In addition, population pressure can a reason of migration for some rural residence and therefore divide forests into patches, which breaks the corridor for animal migration and environmental balance. From the evidence of Ecuador and Guatemala, fast growing population can create frontier immigrants who tend to engage in rural to rural migration and seek potential farm lands in the forested area, especially adjacent to the protected areas (Carr, 2009). All of the aforementioned issues create negative results on forest coverage. Their possible correlation with population growth directly pushes the negative coefficient to be larger. Therefore, the negative impact of population growth itself can be overly estimated in this model.

Tourism indicator is one of the four main key variables of concern in this model for that tourism is gaining importance in the region with high emphasis in eco-tourism. Unfortunately, there's no significant result reached according to table 2 in either CAC region or by looking at the data in the entire Latin America context. The reasons that lead to this result can be quite complex. Out of all, the most crucial matter might be that the tourism industry is relatively new in the region, especially for the CAC countries. Tourism has only gradually been gaining larger weights in its economies from the year 2003-2008 when the intraregional efforts on tourism promotion was started to come into effects. (Cañada, 2010). This simply suggests that before the time of 2003, tourism contributes little to nothing for the overall development of the countries in a whole. The relationship between the tourism industry and deforestation therefore was almost non-existed for half of the time of the study period that this paper discussed (1995-2014). The insignificant results are therefore reasonable. However, the coefficient of the CAC region is fairly interesting to look at.

It appears that tourist arrival can create potential negative effects in the forest coverage in CAC region while the region has been promoting the sustainable integration and maintenance of natural resources with tourist attraction sites. However, it is no news that CAC lacks proper regulations, policies and studies to carry out the named propaganda. In the region, the tourism sector is very much carve up by the big foreign investors, small and medium size business and some community initiatives. This thus created disparity among the tourism development models and structures between countries and sometimes even between the country itself (Roman, 2006). Without proper government monitoring, conflicts arise in the region in the excessive real estate construction for tourism. Sewage dumping from construction and abusing the free market for real estate development had all caused serious soil degradation and deforestation and were publicly condemned by local communities and environmental groups in Costa Rica (Morera & Sandoval, 2010). There also comes challenges for implementing new regulatory framework to standardize tourism sectors. High pressure were given by the profit-makers to the government to buy more time and ease off any policy

reform and modifications while their profit gaining activities continue to deteriorate the local environment (Cañada, 2010). For these reasons, the tourism industry wasn't helping to maintain and protect the forestry, but was doing quite the opposite. The possible negative relationship between tourism and forest coverage can therefore be understood. Such negative effects

V. Conclusion

In general, economic development is considered to have negative influence on the environment. Such view is widely proposed and suggested in many countries, particularly in Latin America and the Caribbean region. However, question is raised that whether this theory does hold in the Central America and the Caribbean context. From the data analysis, it is concluded that the economic performance can positively contribute to the maintenance of the current forest coverage and even reforestation in the region. On average, one percent point of economic growth in the CAC region can increase 6.44 percent of forest coverage. The livestock meat production and population growth both can contribute to deforestation in the region. With one percent change in these two variables, there could be a decrease of 4.8 percent and 17 percent of forest coverage respectively. Tourism and forestry industries do not have significant relationship with deforestation in the CAC countries under the scope and timeframe of this study. Also, the level of negative impact of population growth is very likely to be overestimated. Studying the degree of its overestimation of the negative effect can be the object of future work.

The finding of this paper is important because it brings a different argument to the table on the tradeoff issues between development and deforestation for the region. There's are fair reasons to argue that the tradeoff assumption should not be generalized to the CAC countries for their developments are not largely based on the consumption of natural resources. The governments in CAC instead should be further supported with incentives to develop their non-extractive economic activities and industries. Technique transfers and trainings can also be provided through global partnerships on increasing the productivity of livestock farming. In fact, some organizations had started to realize the importance of these initiatives. UNDP had created a manual of cattle feeding method for higher productivity for small size farmers while International Corporation of Development Fund had also started the genetic improvement projects for sheep and goats in Belize (UNPD, 2014 & ICDF, 2015).

However, the urgency of such technical and economic transformation should be recognized and emphasized.

The result of this paper does not suggest that this model perfectly captures all the causes of the deforestation phenomenon using socio and economic indicators. These indicators are chosen to identify the group of individuals or agents that might be the decision makers who made such transformation of landscape a reality. Policies restricting the abuse of resources in the specified industries are necessary to keep the forest alive with abundance.

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