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Deforestation as an indicator of environmental degradation: Analysis of five European countries

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ABSTRACT

This study explores the validity of the Environmental Kuznets Curve (EKC) hypothesis for deforestation in France, Germany, Greece, Portugal and Turkey. The autoregressive distributed lag bounds testing approach was applied on time-series data over the period 1974–2013. Deforestation is considered an indicator of environmental degradation for its relevance as a global environmental concern, being agriculture expansion one of its main causes. Nonetheless, Europe has achieved an expansion of its forest region through policies that have promoted the use of technology in the agricultural sector. The results of long-run coefficients suggest an inverted U-shaped relationship between deforestation and Gross Domestic Product (GDP) per capita in France, Germany, Portugal and Turkey, which supports the EKC hypothesis. Based on the empirical results, we conclude that an increment in agricultural exports does not contribute to an increment in deforestation. Recommendations regarding public policies derive from the analysis of the Granger causality test. For example, deforestation reduction and investment on deforestation reduction will not hurt economic growth in all countries except Greece.

1. Introduction

Deforestation consists in the transformation of a permanent form of forest land into other uses such as agriculture, grazing or urban development (Van Kooten and Bulte, 2000). Although the expansion on agriculture and livestock, and the use of timber as raw material for fuel have been necessary for economic growth of countries, they have also caused the disappearance of half of the world's forests. This has generated the loss of biodiversity (plants, animals) in different areas of the planet (Noble et al., 2000). Deforestation also causes climatic disruption on the planet, for example, by increasing CO_2 emissions. In fact, deforestation is the second largest anthropogenic source of carbon dioxide to the atmosphere, after fossil fuel combustion (Van der Werf et al., 2009). This is because the trees and soils of tropical forests store large amounts of carbon. When trees are burned to clear farmland, that carbon, turns into carbon dioxide, which is one of the greenhouse gases that accelerate climate change, increasing environmental degradation (FAO, 2015). In addition, the destruction of forests reduces the ability of the planet to absorb CO_2 from the atmosphere (Van der Werf et al., 2009). Even more, according to the Commission of the European Communities (2008), tropical forests capture about 15% of the CO_2 we produce.

Many studies have analyzed the relationship between environmental degradation and economic growth based on the concept of the Environmental Kuznets Curve (EKC), initially posed by Kuznets (1955). The EKC proposes the following hypothesis: In the first stage of economic growth, there is a positive relationship between environmental degradation and growth until reaching a turning point, where the relationship takes the form of an inverted U. Thus, higher economic growth leads to an environmental improvement (Grossman and Krueger, 1995; Tiwari et al., 2013; Onafowora and Owoye, 2014; Jebli, 2016; Zambrano-Monserrate et al., 2016c).

The scope of analysis is wide. Some studies proxy environmental degradation by using as dependent variable the CO_2 emissions from the whole economy (Kasman and Duman, 2015; Azam and Khan, 2016; Zambrano-Monserrate et al., 2016a), SO_2 emissions (Wang et al., 2015; Sinha and Bhattacharya, 2016), or N_2O emissions from agriculture (Zambrano-Monserrate and Fernandez, 2017). Another body of literature proxies degradation by deforestation rates, because of the direct effects of growth on natural capital in order to accommodate productive efforts (e.g. agriculture) (Indarto and Mutaqin, 2016). Thus, Waluyo and Terawaki (2016) analyze the relationship between economic development and deforestation rates in Indonesia. Their results support the long-run inverted-U relationship, which implies that, while the

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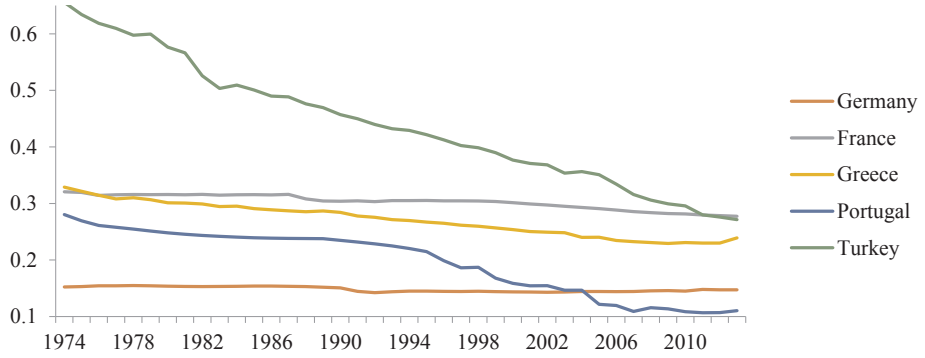

Fig. 1. Arable land per capita (in hectares).

deforestation rate increases at the initial stage of economic growth, it declines after a threshold point. The turning point of the EKC was calculated to be at US$ 990.4 per capita. Likewise, Ewers (2006) finds that high-income countries with low forest cover have the highest rates of afforestation, typically due to the establishment of new plantations. In contrast, low-income countries, with little forest, are more likely to consume that remaining portion at a proportionally faster rate than low-income countries with significant forest resources. Nations with large amounts of forest have approximately equal deforestation rates, regardless of national wealth. The results highlight that there is a strong interaction between forest cover and economic development, which determines rates of forest change among nations. In fact, in terms of policy implications, Bhattarai and Hammig (2001) and Culas (2007, 2012) suggest that strengthening environmental policies and institutions would help to mitigate deforestation without hindering growth. Ehrhardt-Martinez et al. (2002) demonstrate the existence of an EKC for deforestation based on structural and political modernization, where the dynamics are associated with urbanization, service sector growth, and strong democratic states. Esmaeili and Nasrnia (2014), Ahmed et al. (2015) and Polomé and Trotignon (2016) confirm the existence of an EKC for deforestation in Iran, Pakistan and Brazil respectively. These countries characterize for their heavy reliance on land clearing to promote agricultural expansion.

Deforestation in Europe has decreased in the last decades. In fact, Fuchs et al. (2014) find that forest areas in Europe has increased more than a third between 1900 and 2010. In their study, they detailed three possible reasons for this result. First, in the early twentieth century, timber and wood used to be critical inputs for the production of many goods (e.g. construction, shipbuilding), but after World War II, production technology switched to other inputs, such that pressure on forests moderated. Second, cropland, and consequently pressure on forestland reduced because of technological innovations in agriculture. This lead to increases in productivity, thus, the same amount of food was produced using less land; and, third, there was a massive migration from rural areas to cities. Moreover, Mather (2001) points out that the reduction of deforestation in Europe is due to technological improvements in agriculture, agriculture concentration in more productive areas, changing sources of energy from fuelwood to coal and different government policies. The European Union (EU) has no forest policy per se, but each Member State is free to formulate their own forest policy in accordance with the principle of subsidiarity in the EU Treaty (European Commission, 2016). Nevertheless, the EU has a long history of contributing through its policies to implement sustainable forest management. The European Commission also implemented some important reforms (European Commission, 1998, European Commission, 2005, European Commission, 2010, Europern Commission, 2013b). The EU afforestation actions promoted since 1990 were developed within the Common Agricultural Policy (CAP) and they mainly occurred on agricultural land (Zanchi et. al., 2007). The CAP encouraged the agricultural sector to modernize rapidly. It has been very effective in increasing productivity, and promoting research and innovation (European Environment Agency, 2011; European Commission, 2014). Europe has succeeded in developing modern agricultural production systems where higher yields per hectare are reached because of genetic improvements, mechanization, drainage, irrigation and the application of fertilizers and pesticides, which altogether mitigate pressure on land; therefore, this avoids increasing the arable lands (European Environment Agency, 2000).

The purpose of this study is to investigate the existence of an EKC in five continental European countries. We chose France, Germany, Greece, Portugal and Turkey as case studies. When choosing the European countries, their location was considered as main criteria, taking into account western, central and eastern nations in order to evaluate forests along the continent. Moreover, despite the importance of deforestation as an indicator of environmental degradation, there are no previous studies on the subject in the countries analyzed. In addition, because deforestation is closely linked to agricultural expansion (Chakravarty et al., 2012; Chaplin-Kramer et al., 2015), the variable arable land area per capita was chosen, as an indicator for deforestation. This variable has already been included in previous studies such as Scrieciu (2007), Chiu (2012) and Choumert et al. (2013). In the countries studied, arable land has shown a decrement in the period analyzed. For instance, Germany, France and Greece's arable land per capita decreased at 0.2%, 0.3% and 0.9% respectively. Meanwhile, Portugal and Turkey's arable land reduction was higher in comparison at 2.6% and 2.1% (Fig. 1). In addition to arable land, agricultural exports have been considered as a covariate because of their consistent influence on the expansion of agricultural land (Barbier and Burgess, 2001; Barbier, 2004). DeFries et al. (2010) find, within this context, that when demand for agricultural products grows in these countries, they are likely to experience pressures on their forest areas. These countries, in fact, have increased both their forest cover and agricultural exports without imposing severe compromises on forest areas (FAO, 2017). Thus, our hypothesis is that agricultural exports do not increase deforestation. The implementation of technology could counteract the effect of deforestation, increasing the productivity in the European agricultural sector. In the period studied (1974–2013), agricultural exports per capita have increased 6.5%, 5.8%, 0.6%, 8% and 1.02% for Germany, France, Greece, Portugal and Turkey, respectively (Fig. 2). Finally, according to the EKC theory, we have considered Gross Domestic Product (GDP) per capita as a covariate as well. In Fig. 3, a constant growth rate can be seen in the five countries chosen. Germany's real GDP per capita increased with an annual rate of 1.73%. The scenario in France, Greece, Portugal and Turkey is quite similar. Over the same period, their real GDP per capita increased 1.55%, 1.3%, 2.2% and 2.2% respectively.

To test the presence of an EKC in these five countries we use the Autoregressive Distributed Lag (ARDL) Model. This technique is superior to traditional cointegration approaches due to some aspects. The ARDL bounds testing approach is suitable to apply for long-run

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