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How does environmental regulation affect production location of non-carbon ecological footprint?

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A B S T R A C T

The aim of the paper is to investigate how the location of non-carbon ecological footprint (home or abroad) changes along with environmental regulation. Ecological footprint measures the amount of biocapacity required to sustain the consumption patterns of human beings. Employing panel data analysis, the relationship between income and footprints that result from domestic production and importsis investigated for 87 countries during the period 2004-2010 within the Environmental Kuznets Curve (EKC) framework.

We find that an EKC relationship cannot be validated for income (GDP per capita) and non-carbon footprints of production and of imports. Besides, the analysis shows that countries reach the turning points for import footprint at lower levels of income once stringency of environmental regulation and enforcement of environmental regulation are accounted for. Environmental regulations push the economic structure towards a cleaner transformation by which resources can be exploited more effectively, and short run losses in economic growth can be avoided in the medium and long run, conditional on a successful transformation toward higher value-added and cleaner production processes.

1. Introduction

The pressure on nature has various aspects. These may include depletion of renewable resources such as fish stocks, or of non-renewables including oil, growing solid wastes and greenhouse gas emissions, loss of ecosystem services, deterioration of land use, etc. The goal of this paper is to reveal the effect of environmental regulations along with economic growth on the location (home or abroad) of non-carbon ecological footprint.

When analysing the impact of economic growth on the location of production, it can be argued that it is more appropriate to decompose ecological footprint into its carbon and non-carbon components (the latter being the sum of the grazing land, cropland, built-up land, fishing and forest footprints). This is simply because the carbon footprint of energy (from oil, natural gas and coal resources) affects environment mostly in the location of consumption rather than the location of production. It is exactly the opposite for non-carbon ecological footprint. Footprints created by forestry or crop production insert pressure on environment where production takes place.

The first substantial increase in the impact of human activity on nature took place with the transition to settled agriculture, and the second boom resulted from the Industrial Revolution (WorldWatch Institute, 2015). However, the question of the impact of economic growth on nature (environmental quality) has come to occupy economists' agenda since the end of the 1960s. Since then the relationship between growth and environment has been analyzed by different schools, ranging from mainstream environmental economics to more radical political ecology. Mainstream "environmental economics" argued that the negative effects of growth on nature stemmed from *lack of markets,* and suggested, as a policy proposal, that nature be made subject to market mechanisms just like manufactured goods. The "interventionist" school, also within the mainstream, has claimed that the social optimum should be reached by means of taxation and regulation, basing their arguments on the assumption that negative effects (negative externalities) are an indicator of *market failure*. On the other hand, "political ecology", an approach outside the mainstream, renounces the view that sees nature as a natural resource reserve and asserts that confining the issue to lack of markets, existence of market

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distortions or failure obscures the power relations among actors. According to this standpoint, nature has inherent rights, and it is not adequate to commodify and subject it to the same procedures as other human-made commodities.

WWF (2012) identifies 1975 as the year in which consumption generated ecological footprint exceeded the Earth's biological capacity. It was also the same period when such issues as environmental pollution and rapid depletion of non-renewable natural resources, which stem from economic activities including production and consumption and are referred to as "negative externalities" in the economics literature, came to occupy a more critical place on the economists' agenda.

The beginning of the 1970s saw the development of a formulation called IPAT. Being the end result of the exchange of opinions between Commoner, Ehrlich, and Holdren, this formulation encapsulates the effects of human activity on the environment (Commoner et al., 1971; Ehrlich and Holdren, 1971). In this formulation, "I" stands for Impact, "P" for Population, "A" for Affluence (defined as per capita income), and "T" for Technology.

The first prominent reaction against the understanding that natural resources could be exploited limitlessly for the sake of economic development came about in the form of a report entitled "The Limits to Growth", sponsored by the Club of Rome in 1972 (Meadows et al., 1972). "World models", which were developed by employing the system dynamics method, stirred up questions about the "sustainability" of economic activities as they revealed that economic growth cannot continue forever and humanity will reach to the limits of natural resources at some point. The term "sustainability" was first introduced in the "World Conservation Strategy" report, dated 1980 (IUCN et al., 1980). However, the concept was popularized in 1987 by the well-known "Our Common Future" report, also known as the Brundtland Report (WCED, 1987).

Developing indicators to measure the level of sustainability became one of the main objectives of Agenda 21, adopted by the United Nations in 1992. There exist many indicators that assess the impact of economic activities on nature from different perspectives (for a detailed analysis, see Singh et al., 2012). Some of these indicators are one-dimensional (e.g., CO_2 emissions), while others involve different dimensions including deforestation, depletion of fish stocks, and natural resource consumption.

The roles attributed to economic growth by the mainstream economic thought are not confined to the economic sphere. It is predominantly anticipated that economic growth will be a panacea for social and ecological problems as well. According to one of the most prevalent hypotheses in the literature that explores the impact of growth on the environment (environmental quality), environmental pollution increases with economic growth at low income levels. For Grossman and Krueger (1991), pollution is expected to decrease when a certain income level is reached. This indicates an inverted U-shaped relationship between income and environmental pollution, and the resultant curve is called the Environmental Kuznets Curve (EKC). The EKC hypothesis suggests that the effects of economic growth or GDP on the environment are carried out through three channels: the "scale", "composition and "technology" channels. The negative scale effect (increasing consumption due to increasing affluence) tends to prevail in the initial stages of economic growth, but after some income per capita threshold it should be outweighed by the change in the composition of production (shift towards cleaner sectors) and by the change in technology employed (shift towards cleaner technologies). Following Grossman and Krueger (1991), other scholars attempt to uncover the nature of the relationship between income and different environmental quality indicators. Boulatoff and Jenkins (2010) select, in their studies, exclusively CO_2 and SO_2 quantities in the atmosphere as the environmental quality indicators. Ehrhardt-Martinez et al. (2002) exclusively employs deforestation while Grossman and Krueger (1995) uses heavy metal pollution alone. Some of these studies verified the EKC hypothesis (see Shafik and Bandyopadhyay, 1992; Kaufmann et al., 1998; Stern and Common, 2001) while others reached contradicting results (see Akbostancı et al., 2009). Therefore, it is not possible to assume a unique curve for all types of environmental degradation (see Dinda (2004) and Carson (2010) for a critical survey of the recent EKC literature).

The standard EKC literature may be criticized on two fronts. First, the relationship between income and environmental quality does not lend itself to be quantified, or generalized, by using a single indicator such as CO_2 or CO_2-equivalent emissions. Consumption growth driven by increasing income has numerous multi-dimensional repercussions, ranging from air pollution to deforestation, to depletion of fish stocks and of agricultural land. For this reason, employing aggregate, rather than one-dimensional, environmental quality indicators (such as ecological footprint) will help to obtain more holistic results. Al-Mulali et al. (2015) is one of the studies that employs ecological footprint as an indicator for the 1980–2008 period. Caviglia-Harris et al. (2009) do not find an EKC relationship between ecological footprint and income for an unbalanced panel of 146 countries during the period 1961–2000; however they detect limited evidence for an EKC among the components of ecological footprint. Another example is a country study by Acar and Asıcı (2017), who find that consumption, import and export footprints monotonically increase with income, whereas an EKC-type relationship is only available between production footprint and income in the period 1961-2008. Controlling for socio-demographic variables such as urbanization, life expectancy at birth and fertility rate, Charfeddine and Mrabet (2017) finds results that support the EKC hypothesis for the oil-exporting countries in the MENA region, while they find a U-shaped relationship for the non-oil-exporting countries of the region.

The second criticism relates to the geographical area at which indicators are measured. As can be seen in the above-mentioned studies, indicators are mostly based on "domestic production/consumption" which can only measure the impact of consumption on domestic environment. **Yet, income growth leads to increased demand not only for domestic products, but also for foreign goods imported from abroad for domestic consumption. In other words, testing EKC hypothesis with an indicator like deforestation for example would yield biased results if countries are able to import forestry products from abroad, which is indeed the case**. As countries get wealthier, they may prefer to export their natural resource-intensive, polluting industries (such as paper, cement, iron-steel industries) and import finished goods. In this way, they can improve environmental quality and relieve the pressure on natural resources within their respective countries. In the literature, there are studies that draw attention to this situation. For instance, Wang et al. (2013) reaches the conclusion that domestic consumption/production related ecological footprint is affected by the consumption/production ecological footprints, income levels and biological capacities of neighbouring countries. Wiedman (2009) carries out a comprehensive assessment of studies that explore the degree with which international trade impacts on pollution within the context of producer-consumer responsibility. Poelhekke and van der Ploeg (2014) notes that the recently growing foreign direct capital investments (FDI) mostly take the form of shifting energy and natural resource-intensive, polluting industries in developed countries to developing and less developed ones. In a similar vein, Lau et al. (2014) reports that increased FDI and trade openness lead to diminished environmental quality. Therefore, it may not be suprising to observe enriching countries to transform their production composition