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The carbon footprint of countries' production and imports: an Environmental Kuznets Curve approach

Ahmet ATIL AŞICI*
Sevil ACAR**

Abstract - As unveiled by the literature that examines environmental quality along with economic development, growth is expected to bear different environmental consequences at different levels of income per capita. The widely-known Environmental Kuznets Curve (EKC) hypothesis suggests an inverted-U shaped relationship between per capita income and environmental degradation. One channel leading to this phenomenon is called the "composition effect" that arises from a shift in industrial sectors, i.e. from polluting manufacturing to cleaner sectors. Consequently, it is widely observed that countries that get richer have been relocating their polluting industries abroad. In this study, we focus on carbon footprint resulting from domestic production versus imports and analyse the factors that determine carbon footprint. Our sample consists of a cross-section of 146 high, middle and low income countries for the year 2006. Controlling for the effects of openness to trade, biological capacity, population density, industry share, energy use, and environmental regulation, we detect an EKC-type relationship between per capita income and carbon footprint of domestic production. On the other hand, carbon footprint of imports increases as income per capita grows.

JEL Classification
Q01; Q20; Q50; Q56; Q58

Key-words
Carbon footprint
Environmental Kuznets curve
Pollution haven

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* Istanbul Technical University, Department of Management Engineering ; asici@itu.edu.tr
** Altınbaş University (formerly Istanbul Kemerburgaz University), Department of Economics ; and Researcher at Boğaziçi University - Center for Climate Change and Policy Studies; sevil.acar@altinbas.edu.tr

1. INTRODUCTION

Today's developed countries increased their living standards at the expense of nature while they were rapidly industrializing and did not mind the damage that was born upon the environment. It has been expected that at some point, after a certain prosperity level, environmental degradation would decline because getting richer would make those countries adapt environmentally-friendly production processes or technologies. At the same time preferences of people would evolve more responsibly towards cleaner goods and services which would not generate environmental costs. However, the dreams did not come true at all parts of the world. Besides, since environmental damage is not a regional problem that concerns only the locals of a region; increased greenhouse gas emissions, particulate matter, and waste of all kinds have started to be overhanging all over the world.

The need to "cool down" the earth necessitates various measures to be taken, among which is the "substantial and sustained reductions of greenhouse gas emissions" (IPCC, 2013). These emissions are triggered by "dirty" industrial production as well as human consumption. Carbon footprint is one of the indicators that reflect human influence on climate as well as the use of resources. It shows the area required to sequester enough carbon emissions in order to avoid an increase in atmospheric CO_2.

In light of these, the current paper investigates whether carbon footprint can be lowered down as countries grow richer or whether it is relocated abroad. In other words, is economic growth a panacea for environmental degradation that is represented by carbon footprint? If so, what are the levels of economic activity that might reverse the situation in favour of the environment? Which other factors play a role in triggering or discouraging carbon footprint of human activity at home country and abroad? We search for answers to these questions throughout this study.

The organization of the paper is as follows. Section 2 undertakes a review of the existing studies which focus on the relationship between economic growth and environmental quality. Section 3 introduces the data and explains the methodology to analyze the research question. Section 4 summarizes the results of the analysis and finally, Section 5 concludes.

2. A REVIEW OF THE LITERATURE ON THE ECONOMIC GROWTH-ENVIRONMENT NEXUS

There is a vast literature on the effects of economic growth, namely per capita income growth, on environmental quality or environmental degradation. Most of this literature deals with the question whether higher levels of gross domestic product (GDP) brings about environmental gains e.g. a decline in specific emissions, hazardous waste or other pollutants. Some studies utilize composite environmental indicators such as the environmental performance index, ecological footprint or biodiversity measured and reported by various institutions. Needless to say, every indicator has its advantages and disadvantages in addressing the exact level of environmental degradation.

Accelerating in the beginning of 1990s, research on the so-called Environmental Kuznets Curve (EKC) hypothesis focuses on per capita GDP and its impact on environmental outcomes. The hypothesis anticipates increasing pollution levels at initial phases of income growth and a turn-around of emissions or environmental degradation after a certain income level is reached, which is depicted with an inverted-U shaped figure. Grossman and Krueger (1993) was the first to analyze the environmental impacts of the North American Free Trade agreement along with economic growth. Later on, other studies as well as Grossman and Krueger (1995) tackled with the same question attributing the EKC results to scale, composition and technique effects. These channels together with other factors such as trade and institutions are investigated in a number of studies in different contexts and via various methodologies (i.e. Selden and Song, 1994; Hettige et al. 2000; Stern, 2004). The findings depend on the data coverage and method of analysis; but in summary, the EKC hypothesis is not always validated.

Another strand of research concentrates on the relocation of polluting industries towards low income countries mainly due to high environmental standards and stringent regulations in high income countries. This type of displacement and responses of firms to differences in environmental rules in different regions are examined through the lens of "pollution haven" hypothesis. This hypothesis is tested by several studies and supported by some (i.e. Mani and Wheeler, 1998; Lucas et al. 1992; Birdsall and Wheeler, 1993; Suri and Chapman, 1998; Atici and Kurt, 2007) while some others (i.e. Tobey, 1990; Jaffe et al., 1995; and Janicke et al., 1997) do not come up with any evidence for such relocation.

The current study intends to carry-out a consumption-based analysis for investigating the consequences of income growth for environmental degradation. The underlying reason is that pressure on the environment may not be tackled via to the aforementioned factors such as composition and technique effects. Hence there is no automatic transition to environmentally-friendly production patterns or greener industries with increased income as the EKC hypothesis presumes. Besides, environmental regulations or consumption preferences of people in favour of environmentally-friendly goods may not necessarily result in the production of cleaner goods in the domestic economy since international trade allows for polluting imports that are not domestically produced (Ekins, 1997). To handle these issues, we specifically focus on the carbon footprint, which is a part of ecological footprint, and seek for an answer to whether higher levels of income bear lower carbon footprint at home and abroad as countries get richer. Carbon footprint is a consumption-based indicator in the sense that human activities such as fossil fuel consumption, harmful land use practices, and forest fires emit CO_2 into the atmosphere. It embodies the CO_2 emissions due to human activity in a given year; in other words, the annual anthropogenic emissions (production) of CO_2. The amount of anthropogenic emissions sequestered by oceans is deducted from these emissions and the difference is divided by the annual rate of carbon uptake per hectare of world average forest land (Borucke et al., 2013: 525). Global Footprint Network reports that ecological footprint of the human-being in 2008 was comprised of 22% cropland, 8% grazing land, 10% forest land, 4% fishing ground, 54% carbon uptake land, and 2% built-up land. Apparently, carbon had the highest portion among all constituents of environmental damage caused by humans.

The relationship between ecological footprint and income has been addressed less frequently in the literature. Bagliani et al. (2008) is one of these studies that inquire the consumption-based approach to seek for evidence for the EKC hypothesis. Their findings do not provide evidence for de-linking; hence an inverted-U shaped curve relation is not validated in any of the estimated models. Instead what they find is a positive association of ecological footprint with higher GDP per capita. They attribute the absence of EKCs to the fact that ecological footprint as a consumption-based indicator accounts for the dislocation of environmental damage away from high-income towards low income countries. Thus, they state that richer countries displace their production, either by trade or foreign direct investment, towards poorer ones by importing the polluting goods or those that require polluting technologies (Bagliani et al., 2008: 659).

There is no doubt that economic growth is not the sole determinant of environmental footprint and its components. Studies have concentrated on several control variables that might affect human demand for land use. For instance, York et al. (2004) perform an OLS regression to analyze the effects on ecological footprint intensity (which is equal to ecological footprint divided by GDP), of GDP per capita, share of services sector in the economy, share of urban population, population density, latitude and type of economy (capitalist or not) in 139 countries. While they find negative and significant coefficients for GDP per capita and population density; higher urban population and being situated at the arctic and temperate regions (with respect to tropical region) trigger footprint intensity.

The contributions of the current paper to the relevant literature can be listed as follows: The analysis is built upon "carbon footprint" only, as opposed to total ecological footprint, which is more commonly used in the EKC literature. Second, the analysis concentrates on the choice of production "location", which is also a novel approach. We do so by separating carbon footprint into carbon footprint of domestic production and that of imports. Such segmentation provides us the ability to account for the effects of GDP per capita and regulations on the location of footprint. Third, we integrate two environmental regulation variables into the standard EKC model: stringency of environmental regulation and enforcement of environmental regulation, both taken from World Economic Forum's Executive Opinion Surveys. With these two variables, we aim to take into account the factors pushing out dirty (high-carbon) industries from strictly regulated countries towards less regulated ones. To our knowledge, these variables have not been employed in similar context before in the relevant literature.

3. DATA AND METHODOLOGY

3.1 Data

This study analyses how the location of carbon footprint (home or abroad) changes with income for a sample of 146 high, middle and low income countries for the year 2006.[1] Footprint data is taken from the Global Footprint Network (GFN, 2012). Data measuring the stringency of environmental regulation and its enforcement is taken from the World Economic Forum's Executive Opinion Survey for the year 2006. All other explanatory variables are extracted from World Development Indicators (WDI) database of the World Bank (World Bank, 2013), and are summarized in Table 1.

Footprint calculation method was developed by Wackernagel and Rees (1996). It shows the amount of geographical area required by human beings, adjusted for fertility, in order to meet the natural resource needs of various economic activities, which serve consumption at the end. The unit of measurement is global hectares (gha).

GFN reports ecological footprint of consumption along two axes; in terms of different economic activities such as domestic production, export and import footprint, and in terms of land types such as cropland, forest land, carbon capture, grazing land, fishing land and built-up land. Figure 1 displays a comparison of these components for countries at different income levels. Apparently, carbon footprint makes the highest portions in middle and high income countries.

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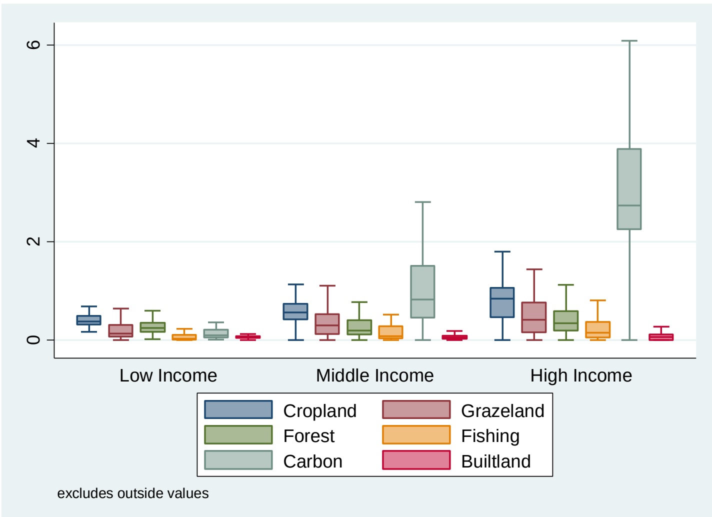
[1] Global Footprint Network's 2012 dataset contains data up until 2008. Given the global economic crisis which started in the end of 2007 and early 2008, we prefer to base our analysis on the year 2006. Although not reported here for space constraints, results are fairly robust to the year selection. The income classification is based on the information taken from: http://data.worldbank.org/about/countryclassifications/a-short-history.

Table 1. Descriptive Statistics

Variables	Mean	Median	Min	Max
Carbon Footprint of Imports (per capita)	0.91	0.26	0	17.8
Carbon Footprint of Production (per capita)	1.37	0.54	0	32.7
GDP per capita	8,325	2,332	95	85,943
Openness to trade	94.50	85.92	25.83	437.4
Biological capacity (per capita)	3.46	1.40	0	89.4
Population density	0.26	0.074	0.00	17.6
Industry share	30.93	28.39	5.69	94.4
Energy use per capita	2.24	1.085	0.01	18.7
Stringency of environmental regulation	3.93	3.69	2.28	6.4
Enforcement of environmental regulation	3.78	3.54	2.27	6.2

Note: See Table A1 for a detailed explanation and sources of all variables.

Figure 1. The Components of per capita Ecological Footprint of Consumption in 2006

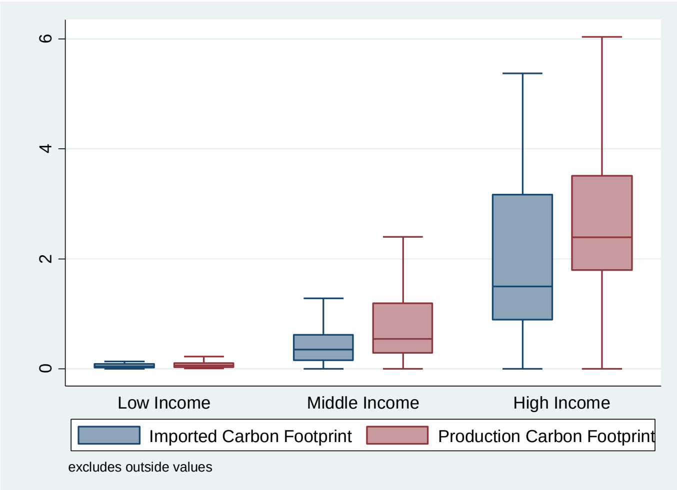


Consumption exerts pressure on natural environment along different dimensions. Food consumption requires crop land whereas timber consumption requires forests. But a country's cropland and forestland biocapacities are not limitless. Consumption footprint that is higher than the biocapacity of the corresponding land type, which is called as ecological overshoot, results in the depletion of biocapacity (i.e. consuming more timber than the amount forests grow in a year is only possible by reducing the forest size). Consuming more than what biocapacity offers is also possible by importing biocapacity from abroad.

There are various sources of CO_2 that is released into the atmosphere, including human activities such as burning fossil fuels and certain land use practices, as well as natural events such as forest fires, volcanoes, and respiration by animals and microbes (Ewing et al., 2010). Carbon footprint shows the area requirement to sequester enough carbon emissions to avoid an increase in atmospheric CO_2. In other words, it measures the uptake land to accommodate carbon footprint. Note that since oceans absorb about 35% of the CO_2 emissions from fossil fuel combustion, only the remaining %65 is accounted for (Wackernagel et al., 2002).

As of 2006, carbon footprint accounts for one third of consumption footprint on average. Figure 2 reveals that the relative importance of carbon footprint is high for middle and much higher for high income countries than that for low income countries. Besides, carbon footprint of imports is quite close to that of domestic production for high income countries.

Figure 2. Import and Production Footprints of Carbon in 2006, per capita

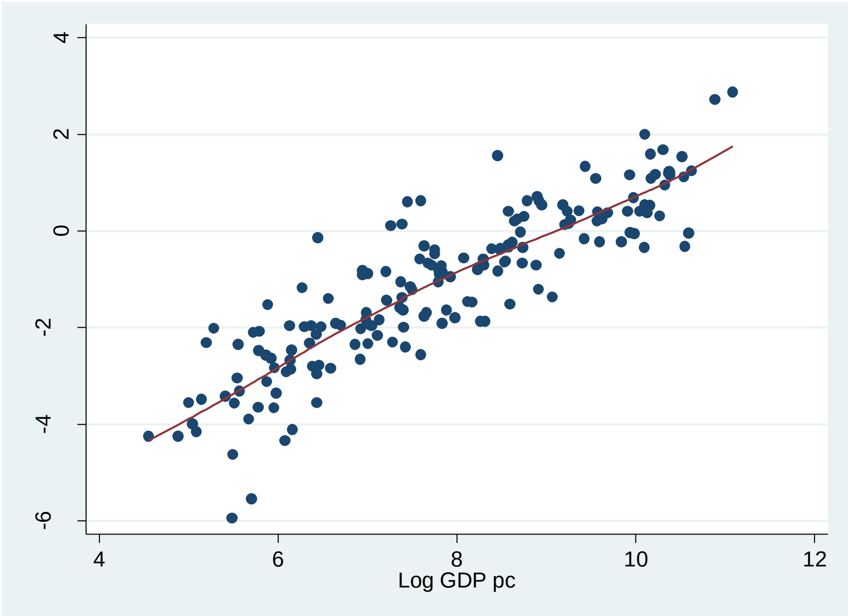


In order to sustain their consumption levels, countries rely on their domestic and foreign biocapacities. International trade allows countries to import goods that are not producible with the available resources of a domestic economy. Plausibly, countries tend to import biocapacity (and hence partly cover their ecological footprint) from other countries for two reasons. First of all, a country's factor endowments may not enable producing such goods (e.g. Saudi Arabia needs to import timber because it has no enough forest biocapacity to serve domestic needs). Second, even if a country may have enough biocapacity to produce such goods, it may choose not to produce it domestically but to import from foreign suppliers due to several reasons. Most notably, the opportunity to import lower-cost goods from abroad or the existence of heavy environmental regulations at home country may dislocate the production of goods to countries where environmental regulations are weaker.

Figures 3 and 4 plot carbon footprints of imports and of production respectively, against income per capita for the sample countries in the year 2006. In other words, these figures shed light on the production location of carbon footprint (abroad versus home). What we notice is that, both types of carbon footprints rise with income. However, carbon footprint of imports rises much faster than that of domestic production, displayed by a steeper curve for the former.

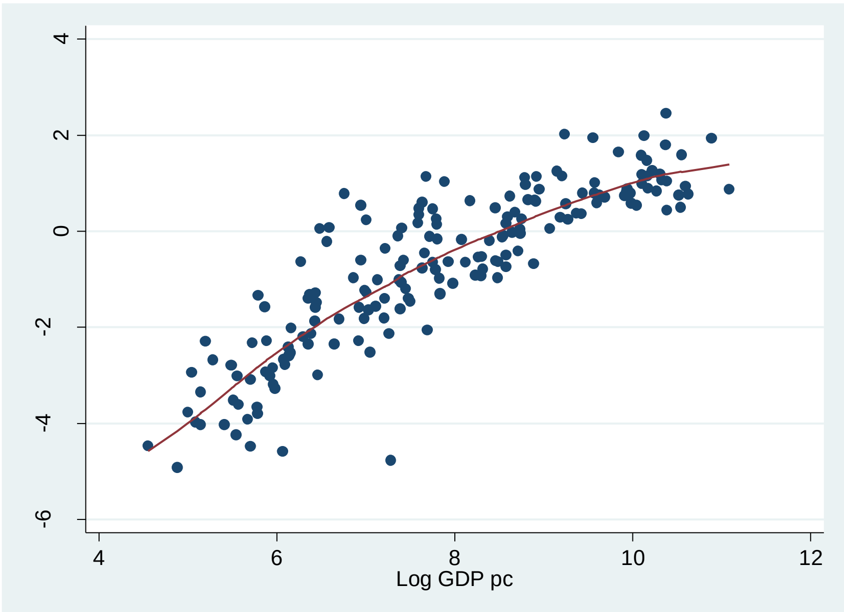
Our preliminary analysis based on the scatter plots signals that countries tend to import rather than produce domestically the carbon-intensive goods as they grow richer. In the next section, we formally analyse income-carbon footprint relationship with the help of a set of explantory variables that are thought to be influential for the origin of production determination.

Figure 3. Carbon Footprint of Imports (pc gha) vs. GDP per capita, 2006



Notes: See Table A1 for data definitions. The line represents Lowess function estimated with a bandwidth of 0.8.

Figure 4. Carbon Footprint of Production (pc gha) vs. GDP per capita, 2006



Notes: See Table A1 for data definitions. The line represents Lowess function estimated with a bandwidth of 0.8.

3.2. Econometric Model

We will use the following simple econometric model for our analysis:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \beta_3 Z_i + \varepsilon_i \qquad (1)$$

where y_i is the carbon footprint indicator of country *i*; x_i is the log of GDP per capita in constant US$, and Z_i is the vector of all other covariates[2] of country *i* in year 2006. ε_i is the error term, capturing all other omitted factors with $E(\varepsilon_i) = 0$ for all *i*.

(1) will be estimated twice using two versions of the ecological footprint indicator as the dependent variables: the log of per capita carbon footprint of imports (*lefmca*) and the log of per capita carbon footprint of production (*lefpca*) respectively. Each model will also be estimated twice by including the environmental regulation indicators as regressors in a stepwise manner.

The list below presents the possible outcomes:

1. If $\beta_1 > 0$ and β_2 is found to be either insignificant or equal to zero, there is a monotonically increasing relationship;
2. If $\beta_1 < 0$ and β_2 is found to be either insignificant or equal to zero, there is a monotonically decreasing relationship;
3. If $\beta_1 > 0$ and $\beta_2 < 0$, there exists an EKC-type (inverted U-type) relationship;[3]
4. If $\beta_1 < 0$ and $\beta_2 > 0$, there exists a U-type relationship between the relevant footprint indicator and income per capita.

In a cross-section analysis like ours, one of the most commonly faced methodological problem is the existence of heteroskedasticity, which is the violation of the assumption of the constant variance of disturbances, ε_i, appearing in the population regression, conditional on the chosen values of the explanatory variables (Gujarati, 1995: 355). In the case of heteroskedasticity, the estimated coefficients will still be unbiased but not efficient. Moreover, the existence of outliers also creates another problem by rendering ordinary least squares (OLS) estimation inefficient and sometimes biased. One can heal these problems by employing iteratively reweighted least squares (IRLS) regression method, which uses weighted least squares to dampen the influence of outliers. The weights are based on the residuals and measured as the distance between the observation and its predicted value (Andersen, 2008). In this paper, we use M estimation method with Huber weighting function introduced by Huber (1973).[4]

4. RESULTS

Table 2 presents the estimation results of the four regressions we conducted for two dependent variables: carbon footprint of imports and production. First of all, we detect an inverse U-type relationship only between per capita carbon footprint of production and income. As income per capita rises, pc carbon footprint of production (*lefpca*) first tends to increase, and then starts to fall beyond the income thresholds (the turning points are found to be 15,185 and 18,045 US$). Regarding the regressions that use import footprint as the dependent variable, as the turning points are found to be outside the income range of our sample countries,

[2] See Table 1 for the list of the variables employed in the regression analysis.

[3] The turning point for income per capita after which environmental quality improves, in a log-log specification, is equal to $e^{-\frac{\beta_1}{2\beta_2}}$.

[4] For a detailed explanation of robust regression techniques and other weighting functions, see Andersen (2008).

we cannot confirm an EKC-type relationship (although the coefficients of GDP per capita and its square have positive and negative signs respectively).

Table 2. IRLS Regression Results for Carbon Footprint of Imports and Production

	(1)	(2)	(3)	(4)
	lefmca	**lefmca**	**lefpca**	**lefpca**
lgdp	1.567*** (4.31)	1.744*** (3.47)	3.158*** (5.87)	3.293*** (3.98)
lgdpsq	-0.0518** (-2.26)	-0.0646** (-2.01)	-0.164*** (-4.20)	-0.168*** (-3.04)
open	0.0116*** (5.34)	0.0116*** (4.73)	0.00147 (1.30)	0.00221 (1.56)
lbio	-0.0144 (-0.31)	0.0117 (0.26)	-0.0941** (-2.05)	-0.0776 (-1.29)
popden	-0.481*** (-3.11)	-0.481*** (-2.97)	-0.120* (-1.70)	-0.177** (-2.16)
ind	-0.0133*** (-3.10)	-0.0113** (-2.08)	0.00369 (0.95)	0.00312 (0.55)
enpc	0.0550** (2.53)	0.0534*** (2.59)	0.272** (2.49)	0.209* (1.73)
ereg		-0.0958 (-0.42)		-0.353 (-1.30)
enfo		0.180 (0.79)		0.377 (1.43)
_cons	-10.74*** (-7.82)	-11.66*** (-5.70)	-15.68*** (-8.81)	-16.41*** (-5.49)
N	141	107	146	108
R^2 (w)	0.88	0.90	0.87	0.86
R^2 (rho)	0.78	0.82	0.75	0.74
Turning Points	3.7*E6	728,288	15,185	18,045

*Note: t statistics in parentheses. *p < 0.10 **p < 0.05 ***p < 0.01.*

Trade openness (*open*) is found to only affect carbon footprint of imports, yet with a minimal magnitude. The effect is positive as expected.

All else equal, one can hypothesize that countries with abundant biocapacity are less likely to rely on imports. However, we find insignificant coefficients for imported footprint (Eq. 1 and 2), whereas a negative relationship between biocapacity per capita (*lbio*) and carbon footprint of production (pc) is detected (Eq. 3). This may be due to the fact that *lbio* variable contains biocapacities of all land types, and that data for separate carbon capture biocapacity which is measured within forest biocapacity does not exist.

Population density (*popden*) can be expected to affect carbon footprint through two channels: scale and efficiency. On the one hand, denser population requires more infrastructure, which may then increase carbon footprint; but on the other hand, it should be relatively easier to use resources more efficiently in densely populated areas (e.g. thanks to the availability of central heating and relatively broad transportation networks). Our results indicate that the efficiency channel dominates the scale channel. As *popden* increases, carbon footprints of import and production decrease.

Industry value added share in GDP (*ind*) appears to have a small but decreasing effect on environmental pressure only abroad (Eq. 1 and 2). Here again, we can mention the efficiency channel. Given that most countries import energy that is rich in carbon, countries with a higher share of industry may tend to use energy more efficiently and imported carbon footprint decreases accordingly. As expected, energy use per capita (*enpc*) has a significant and positive effect on both carbon footprint of imports and that of production (Eq.1-4).

Last but not the least; we examine the implications of stringency of environmental regulation (*ereg*) and that of environmental regulation enforcement (*enfo*) on the location of environmental pressure. One may expect that more stringent environmental regulation (*ereg*) at home deters carbon-intensive production at home by encouraging imports. Our estimation results, however, do not support this argument. We do not find evidence that higher environmental regulations are associated with less carbon footprint neither at home nor abroad. Regarding the enforcement of environmental regulation (*enfo*), one may expect that carbon footprint will be lower in countries with more rigorous enforcement. However, we find positive but insignificant coefficient estimates for *enfo*. One explanation is that what *enfo* measures is rather broad institutional quality, which is highly correlated with income per capita and which, in turn, is positively related to carbon footprint of both imports and production.

Yet, it is noteworthy to underline that the inclusion of *ereg* and *enfo* dramatically alters the turning points estimated. We find that with the inclusion of these variables, in the case of imported carbon footprint, the turning point for income decreases considerably from 3.7 million US$ to 728,288 US$. Their inclusion, on the other hand, increases the turning point for carbon footprint of production from 15,185 to 18,045 US$. Higher (*lower*) income turning point found for carbon footprint of domestic production (*import*) indicates that stricter environmental regulations and their enforcement at home lead countries to export the negative environmental consequences of their economic activities abroad.

5. CONCLUSIONS

In this paper we analyse the relationship between income per capita and location of carbon footprint. The current study extends the standard EKC literature in two ways. First, we refine income-environmental degradation relationship by incorporating the origin of location into the picture. By doing so, we are able to see the effect of income on carbon footprint that results from production abroad and at home country separately. Our analysis reveals that richer countries tend to export the negative environmental consequences of their economic activities by importing rather than domestically producing carbon-intensive goods. We find an EKC-type relationship between income and carbon footprint of production, for which the income threshold is detected to be at least 15,185 US$.

Second, we augment the standard EKC model with indicators that measure the stringency of environmental regulation and enforcement of such regulation. Although merely insignificant, their inclusion alters the turning points found for import and domestic production. In the case of carbon footprint of production, the threshold increases to 18,045 US$, which hints the deterring role of regulations on environmentally destructive production processes.

Briefly, given the diverging economic, environmental and institutional characteristics of countries, our results support the view that economic growth in itself is not sufficient to mitigate negative environmental externalities. The significantly changed income turning points show the importance of environmental regulation and its enforcement along with economic growth. Our findings are in line with that of Van Alstine and Neumayer (2010), and that "grow now, clean up later" message of standard EKC studies might not be relevant for the majority of developing and least developed countries, given the predictions that many countries will not reach EKC turning points for decades to come.

The increasing amount of imported carbon footprint along with GDP growth (i.e. the lack of evidence for an EKC-type relationship) confirms our claim that countries tend to export the ecological cost of their consumption to poorer economies and this provides support for the pollution haven hypothesis. Hence, the conforming message given by the EKC studies are not validated and hence, countries should do more than only focusing on economic growth if they really intend to combat climate change. One way to address this problem is to reduce their responsibility in carbon emissions and hence carbon footprint born both domestically and abroad.

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APPENDIX - Table A1. Data units and sources

Variable	Description	Unit	Source
lefmca	Log of Carbon Footprint of Imports	Global hectares (per capita gha)	Global Footprint Network, 2012
lefpca	Log of Carbon Footprint of Production	Global hectares (per capita gha)	Global Footprint Network, 2012
lgdp	Log of GDP per capita	Constant US$, in 2000 prices	World Development Indicators (WDI)
open	Openness to Trade	exports + imports, % of GDP	WDI
lbio	Log of Biological Capacity	Global hectares (per capita gha)	Global Footprint Network, 2012
popden	Population Density	1000 people per sq. km of land area	WDI
ind	Industry share	Value added of Manufacturing (% of GDP)	WDI
enpc	Energy use per capita	Tonne of oil equivalent	WDI
ereg	Stringency of Environmental Regulation	1 = very lax; 7 = among the world's most stringent	World Economic Forum Executive Opinion Survey 2008
enfo	Enforcement of Environmental regulations	1 = very lax; 7 = among the world's most rigorous	World Economic Forum Executive Opinion Survey 2008

L'empreinte carbone de la production et des importations des pays : une analyse à partir de la courbe environnementale de Kuznets

Résumé - D'après la littérature qui examine la qualité de l'environnement en relation avec le développement économique, la croissance devrait avoir des conséquences environnementales différentes selon les niveaux de revenu par habitant. L'hypothèse bien connue de la courbe environnementale Kuznets (EKC) suggère une relation en U inversé entre le revenu par habitant et la dégradation de l'environnement. Une des raisons de ce phénomène tient à l'« effet de composition sectorielle », c'est-à-dire à des changements de structure vers des secteurs plus propres avec le développement économique. Ainsi, il est largement observé que les pays qui ont un plus haut niveau de richesse ont délocalisé des industries polluantes à l'étranger. Dans cette étude, nous nous concentrons sur l'empreinte carbone liée à la production nationale et aux importations, et aux différents facteurs qui la déterminent. Notre étude porte en coupe transversale sur 146 pays à revenu élevé, moyen et faible pour l'année 2006. En tenant compte des effets de l'ouverture au commerce, de la capacité biologique, de la densité de la population, de la part des secteurs industriels dans le PIB, de la consommation d'énergie par habitant et de la réglementation environnementale, nous faisons apparaître une relation de type EKC entre le revenu par habitant et l'empreinte carbone de la production nationale. Il apparaît aussi que l'empreinte carbone des importations augmente à mesure que le revenu par habitant s'élève.

Mots-clés

Empreinte carbone
Courbe environnementale de Kuznets
Havre de pollution