ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

2015

working paper series

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Working Paper No. 938

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September 2015

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First published in 2015 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

The aim of this paper is to investigate whether countries tend to relocate their ecological footprint as they grow richer. The analysis is carried out for a cross-section of 105 countries by employing the production and import components of the Ecological Footprint data of the Global Footprint Network belonging to the year 2006. With few exceptions, the existing Environmental Kuznets Curve (EKC) literature concentrates only on the income-environmental degradation nexus in the home country and neglects the negative consequences of home consumption spilled out. Controlling for effects of openness to trade, biological capacity, population density, industry share and energy per capita as well as stringency of environmental regulation and environmental regulation enforcement, we detect an EKC-type relationship between per capita income and footprint of domestic production as well as that of import, although the income turning points for import footprint are found to be out of the income range of the sample. Moreover, we find that domestic environmental regulations do not influence country decisions to import environmentally harmful products from abroad; but they do affect domestic production characteristics. Hence, our findings indicate the importance of environmental regulations and provide support for the “Pollution Haven” and “Race-to-the-Bottom” hypotheses.

JEL Classifications: Q01, Q56, Q57

Keywords: Ecological footprint, Economic growth, Environmental Kuznets Curve, Environmental Regulation

ملخص

الهدف من هذه الورقة هو دراسة ما إذا كانت البلدان تميل لنقل البصمة البيئية الخاصة بها في أوقات النمو وزيادة ثرائها. ويتم تحليل شريحة واسعة من 105 دولة من خلال توظيف عناصر إنتاج واستيراد الخاصة ببيانات البصمة البيئية للشبكة العالمية للبصمة البيئية خلال عام 2006. وفيما عدا استثناءات قليلة، فإن الأدبيات الخاصة بمنحنى كوزنتس البيئي القائم (EKC) تركز فقط على علاقة تدهور الدخل البيئي في الوطن وتهمل الآثار السلبية للاستهلاك المنزلي. وبالسيطرة على عوامل مثل آثار الانفتاح على التجارة، والقدرة البيولوجية، والكثافة السكانية، حصة الصناعة والطاقة للفرد الواحد، وكذلك التشدد في التنظيم البيئي وإنفاذ القوانين البيئية، نكتشف علاقة EKC ما بين دخل الفرد وبصمة الإنتاج المحلي وكذلك تلك التي لعمليات الاستيراد. وعلاوة على ذلك، نجد أن الأنظمة البيئية المحلية لا تؤثر على قرارات الدولة لاستيراد المنتجات الضارة بيئيا من الخارج؛ لكنها أيضا لا تؤثر على خصائص الإنتاج المحلي. وبالتالي، النتائج التي توصلنا إليها تشير إلى أهمية الأنظمة البيئية وتوفير الدعم "لملجأ التلوث " وفرضيات "سباق-إلى-القاع".

1. Introduction

This paper intends to detect whether countries tend to export negative environmental consequences of their consumption as they grow richer, and uncover the factors that drive such behaviour. With the ever-expansion of the world economy, notably in the last three decades, the observation that our globe has already gone beyond its limits in terms of resource use is backed by several environmental indicators (i.e., the Ecological Footprint developed by Wackernagel and Rees (1996)). According to the data provided from the Global Footprint Network (GFN), current global consumption is 50% beyond the Earth's biological capacity (World Wildlife Fund for Nature, 2012). Moreover, among the 199 countries reported, only 60 countries have higher biological capacity than their ecological footprint as of 2008. That means 139 countries ran biological deficits that can only be covered by either importing biological capacity and/or depleting their biological stock, which are not environmentally sustainable ways, given the available stocks and their limited regenerative capacity.

The impact of income growth on domestic environmental quality and natural resources has been investigated extensively in the literature. According to one of the most popular hypothesis, called Environmental Kuznets Curve (EKC), there is an inverse-U-shaped relationship between environmental degradation and economic growth. That is, environmental degradation increases as income increases up to an income threshold and starts to fall. In the majority of the EKC studies, a one-dimensional environmental quality indicator (such as CO_2 emissions, waste, etc.) has been employed and the effects of income on the environment have been measured in the country where production and consumption take place. Yet, it is clear that the effects of economic activities on environmental quality are multi-dimensional rather than one-dimensional. Moreover, in today's globalized world, locations of production and consumption have been changing rapidly. This necessitates the measurement of environmental degradation and natural resource exploitation not only in the location where consumption takes place but also in the production location given the fact that international trade and capital flows make it possible to import rather than produce domestically the goods that are ecologically destructive.

The standard EKC literature, initiated by Grossman and Krueger (1991), indicates three channels through which EKC-type relationship occurs; namely *scale*, *composition* and *technique effects*. The "scale effect" implies increased demand from income and population growth. The "composition effect" refers to the change in the industrial structure from polluting to cleaner industries as income increases. The "technique effect" implies a shift from polluting to clean technology. Income growth fuels consumption, thereby inserting pressure on nature; but income growth also triggers concerns about environment, which, through a democratic process, are expected to be translated into strengthened environmental legislation at home. This brings us to the discussion of whether EKC relationship is quasi-automatic or policy-induced (Grossman et al. 1995; Van Alstine and Neumayer, 2010). Heavy regulation at home may force companies to adopt cleaner technologies at home and/or force dirty industries to migrate abroad where regulations are laxer. Apart from these push factors, it is also observed that many developing countries are forced to lower down their environmental standards in an aim to gain international competitiveness and to attract foreign direct investment which are perceived as essential for sustaining economic growth. Therefore, it is plausible to think that increasing environmental quality in an enriching country could be gained at the expense of degrading the environmental quality abroad. In other words, from a global perspective, an EKC-type relationship at home does not necessarily imply that domestic consumption patterns have been put back on an environmentally sustainable path. By importing rather than producing those goods causing environmental degradation, a society can simply continue its "unsustainable" life-style (Schütz et al., 2004; Mayer et al., 2005; Berlik et al., 2002).

In this paper, we aim at filling in these two gaps in the EKC literature. First, we address the multidimensional property of environmental degradation and natural resource use. Second, we distinguish between environmental pressures created in the domestic economy versus abroad. We employ the multi-dimensional Ecological Footprint data to measure environmental quality and natural resource depletion in a cross-sectional analysis to detect the relationship between income and footprints that result from domestic production and imports for 105 countries in the year 2006 within the EKC framework. Ecological footprint data enables us to track the effect of income on domestic and foreign biological capacities and hence provides a better understanding. Moreover, being a multi-dimensional indicator, it might help us to portray a more general picture.

The outline of the paper is as follows. The following section reviews the relevant literature. The third section describes the data and the model used. In section four, we report the regression results. Finally, section five concludes.

2. Literature Review

The EKC hypothesis, which is the most famous hypothesis of the Ecological Modernization Theory (Mol and Spaargaren, 2000) suggests that the effects of economic growth or income on the environment are carried out through three channels called the "scale," "composition and "technique" channels. The pioneering study by Grossman and Krueger (1991) asserts that the negative scale effect (increasing consumption due to increasing affluence) tend to prevail in the initial stages of economic growth, but after a threshold level of development it should be outweighed by the change in the composition of production (shift toward cleaner sectors) and by the change in technology employed (shift toward cleaner technologies). Following this study, numerous studies have been conducted in search for the existence of an EKC in different countries using various environmental quality indicators. Yet the empirical evidence is mixed, that is, it is not possible to talk about a unique curve for all types of environmental degradation (see Dinda (2004) and Carson (2010) for a critical survey of the recent EKC literature).

Whether it exists or not, the question that the majority of the EKC studies leave unanswered is whether or not environmental pressure is decoupled from income growth on the global scale. An increase in environmental quality after a certain level of income (hence an EKC-type of turn) at home can easily be achieved without altering the unsustainable consumption patterns thanks to the increasing international trade and capital flows. Andersson and Lindroth (2001) lists four different ways of how trade may affect environment, notably the ecological footprints as such: (a) positive *allocative effect*, which reduces ecological footprint as trade enables specialization of countries on products which are produced with a higher yield, (b) negative *income effect*, which increases ecological footprint as trade helps countries raise their income, and thereby, consumption, (c) negative *rich-country-illusion effect*, which highlights the false impression in rich countries that their life style is sustainable which might be formed thanks to the possibility of importing bio- and sink-capacity from poorer countries, and (d) negative *terms-of-trade distortion effect*, which hints the tendency of poorer countries to exploit natural resources beyond sustainable scales to protect themselves from falling terms-of-trade during bust periods in world demand.

The possibility of importing bio- and sink-capacity with rising income also creates another illusion on the side of poor countries that economic growth is the necessary condition for a better environment (Nordström and Vaughan, 1999). This, in the end, causes the ecological footprint to climb up both in rich and poor countries. Therefore, it is indispensable to consider the effects of international trade when dealing with income-environmental quality relationship *a la* EKC. This is what this paper aims at: analysing separately the effect of income (after controlling for several factors) on ecological footprints caused by domestic production and imports.

The positive effects unleashed by increasing income in richer countries (through channels of composition, technique and increasing sensitivity reflected in tightened regulations) could help to clean up domestic environment; but this does not guarantee an overall reduction in environmental degradation globally, if not an increase. There are several ways of importing environmental burden of consumption in rich countries that can be understood in the context of "unequal ecological exchange" among countries (Andersson and Lindroth, 2001). One explanation is that less developed countries extract natural resources and export them to more developed ones so that the latter externalize pollution and environmental costs by means of importing resource-intensive goods or energy materials. Schütz et al. (2004) describes how improvements in the motor-car emission technology, possibly triggered by tightened regulation in the EU countries, relocate polluting production processes in the form of ecological rucksacks and how such relocation increases pollution.[1] They find that the pressure on the environment due to "ecological rucksack" of the EU imports from developing countries stood at 5 to 1: that is, one tonne of imported raw materials resulted in 5 tonnes of erosion or unused extraction material in the countries of origin, whereas imports from newly industrializing countries in Europe carried a burden of only 1.6 tonnes rucksack per tonne of raw materials in the year 2000.

It is also plausible to think that available biocapacity at home will also affect the relationship between income and production and import footprints. Given the level of income, one could expect to observe a higher concern for environmental degradation at home where pollution, congestion and resource scarcity are more threatening (Bagliani et al., 2008; Wang et al., 2013). Additionally, the effects of industry share and energy use per capita could be controlled for in determining the relocation of ecological footprint with respect to income. In line with the EKC hypothesis, one would expect that a higher share of industry in the economy causes increased environmental impact and a shift from industry to services reverts the impact in favour of the environment. Besides, there are also arguments such that industrialization could improve environmental quality if market forces drive industries to become more efficient and to reduce not only resource use but also waste (Mol, 1995; Ozler and Obach, 2009). The impact of energy use, on the other hand, has been investigated by several studies such as Atici (2009), which finds that higher energy use in Central and Eastern Europe generates higher levels of emissions due to the use of environmentally hazardous energy. Similar results in the long run are evidenced for the case of Iran in a study by Saboori and Soleymani (2011).

The effect of environmental regulation on economic activity has been a widely debated policy issue in the previous literature. Some studies advocate that international trade and foreign direct investment favour countries with clearly defined environmental regulations. For instance, analyzing a data set of 29,303 observations from 94 European Fortune Global 500 companies that operate across 77 countries, Rivera and Oh (2013: 243) finds that multinational firms are eager to choose to penetrate into countries with clearer and stable regulations than their home countries during the period 2001–2007. There is a vast literature on the link between regulative characteristics and location of production investigating the so-called "Pollution Haven", "Race-to-the-Bottom" (Daly, 1993; Frankel and Rose, 2005), and "Gains-from-Trade" (Eskeland and Harrison, 2002) hypotheses. While it is intuitively plausible to think that environmental regulations change trade patterns and production locations, empirical evidence is mixed. Some studies find no link between stringency of environmental regulation and trade in polluting industries (see Tobey, 1990; Jaffe et al., 1995; and Janicke et al., 1997). Yet some others find evidence of the pollution haven hypothesis (Mani and Wheeler, 1998; Lucas et al. 1992; Birdsall and Wheeler, 1993). The arguments put forward by those opposing the pollution haven hypothesis are based on: (i) the finding that environmental compliance costs are often minimal

[1] The production of a three-way catalyst, as required by the EU, requires precious metals of the platinum group which has an ecological rucksack of around 300000. Apart from rucksack, Norilsk where the Norilsk Nickel company processes palladium ore with antiquated technology, is at the top of most heavily polluted town list in terms of sulphur-dioxide and heavy metal emissions (Schütz, 2004, p.34).

as a proportion of a firm's total cost (Tobey, 1990); (ii) the fact that investment climate in low regulation countries is already unfavourable due to some characteristics such as corruption, poor infrastructure and institutional quality; (iii) and international reputational concerns of the firms (Cole, 2004). Levinson and Taylor (2008), in a study covering Canada, Mexico and the United States, find empirical support backing the observation that pollution control expenditures have significant impacts on trade patterns. On the other hand, in a sectoral study, Poelhekke and Van der Ploeg, (2012) argue that pollution haven and race-to-the-bottom hypotheses are valid in conventional "dirty" industries, whereas data supports gains-from-trade hypothesis in industries like telecommunication, automotive and transportation.

On the other hand, enforcement of regulations and quality of institutions can be argued to be as important as the stringency of environmental regulations. For example, Lopez and Mitra (2004) adds a corruption variable to a standard EKC model and finds that although EKC type relationship still holds, turning points will be higher in the augmented model than the one in the standard model. On the other hand, a theoretical model built by Cheng and Lai (2012), shows that, in the presence of lobbying, a stricter enforcement policy may induce polluting firms, which are required to pay higher emission taxes, to exert more political pressure, which consequently may lead to even more pollution.

Along with these factors, it is required to control for other country-specific characteristics in order to make cross-country comparisons of environmental performance. For instance, population density should be accounted for if one intends to measure decoupling of environmental pressure from economic growth (OECD, 2002).

Taking into account the considerations above, we augment the standard quadratic EKC model with several control variables such as trade openness, population density, industry share in GDP, energy use per capita, and notably stringency and enforcement of environmental regulation. The next section summarizes the data and briefly explains the methodology employed.

3. Data and Methodology

3.1 Data

In this study, we analyse how the production location of footprint (home or abroad) changes with income examining a sample of 105 high, middle and low-income countries for the year 2006.[2]

We utilize the Global Footprint Network's 2012 Dataset where "Ecological Footprint" of ***consumption*** is measured as the sum of ecological footprint of ***production*** (domestic) and ***imports*** minus that of ***exports***. Footprint calculation method was developed by Wackernagel and Rees (1996) and 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). Each component can also be broken down across different land types such as; c*ropland, grazing land, fishing grounds, forestland, carbon footprint and built-up land.*

Consumption footprint shows the renewable resources required to support people's consumption independently from geographical location. If per capita *consumption footprint* exceeds per capita *biocapacity* (that is, the biosphere's capacity to meet the consumption

[2]The ecological footprint data is extracted from the Global Footprint Network's 2012 dataset in which the latest year available is 2008. In order to isolate the analysis from the global economic crisis that started in 2007, we prefer to base our cross-section 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.

demand) on the global level, this means the existing patterns of consumption in the world cannot be sustained for long (GFN, 2010).[3]

For our purposes in this paper, we concentrate on production, more specifically the effect of income on the location of production, which fuels consumption. As a typical consumption basket of any individual comprises of domestically produced and foreign goods, consumption in a country requires both domestic and foreign resources, which are translated into the ecological footprint of production (*efp*) and that of import (*efm*). Note that footprint of domestic production also includes the footprint caused by the production of goods that are exported, the so-called export footprint by GFN. Since our analysis concentrates on the location of production, the location of consumption (home or abroad) does not matter.

In this study we use two dependent variables, which are;

- Ecological footprint of production (*efp*),
- Ecological footprint of imports (*efm*).

All the independent variables are extracted from World Development Indicators (WDI) database of the World Bank (World Bank, 2013), except the biological capacity data from GFN (2012) and environmental regulation data from World Economic Forum -Executive Opinion Survey (WEF, 2008). The summary statistics for the variables are displayed in Table 1 and definitions are presented in Table A1 in the appendix.

Figure 1 shows the distribution of import and production footprints of countries across income groups. Apparently, import footprint of countries rises with their income and gets closer to their production footprint. Production footprint of low income countries is well beyond their import footprint.

In relation to the income-environment nexus, Figure 2 indicates that the ecological footprint of consumption rises with income per capita when all countries are displayed for the year 2006. Figures 3-4 shed light on the location of production of the ecological footprint. As income increases, import footprints of countries climb up faster than their domestic production footprints. Our preliminary analysis based on the scatter diagrams hints that decoupling of environmental pressure from income does not occur but enriching countries tend to export the negative environmental consequences of their consumption abroad, possibly to poorer countries. In the next section, we formally test these preliminary observations.

3.2 Econometric Model

Consider the following simple econometric model, which will be the basis of 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 ecological 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[4] of country *i* in year 2006.$\varepsilon_i$is the error term, capturing all other omitted factors with E(ε_i) = 0 for all *i*.

Equation 1 will be estimated using the following dependent variables: the log of import footprint (*lefm*) and the log of production footprint (*lefp*).

The possible outcomes can be listed as follows:

1. If β_1> 0 and β_2 is either insignificant or equal to zero, there is a monotonically increasing relationship;

[3]As of 2008, an average world citizen has a consumption footprint of 2.7 gha, whereas available per capita biological capacity of the world is only 1.78 gha. It is straightforward to calculate the number of “earths” that can support this level of consumption, which is 1.52 (2.7/1.78) earths.

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

2. If β_1< 0 and β_2 is either insignificant or equal to zero, there is a monotonically decreasing relationship;
3. If β_1> 0 and β_2< 0, there is an EKC-type (inverted U-type) relationship;[5]
4. Ifβ_1< 0 andβ_2> 0, there is a U-type relationship between the relevant footprint indicator and income per capita.

In a cross-section analysis, one of the important issues that need to be addressed is the problem 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, p. 355). In the case of heteroskedasticity, the estimated coefficients will still be unbiased but not efficient. The second problem that potentially harms estimation results occurs in the presence of outliers that do not come from the same data-generating process with the rest of the data. In the case of outliers, the standard ordinary least squares (OLS) estimation will be inefficient and might be biased. In order to find a remedy to these problems, we conduct our regression analysis 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).[6]

4. Results

Table 2 displays the results from four regressions estimated (two regressions per each dependent variable). To begin with, coefficients of per capita income and its square are all significant and have the signs that confirm the EKC hypothesis. As income per capita rises, footprint of import (*lefm*) as well as that of production (*lefp*) first tend to increase. After a certain threshold point for income, the *lefm* and *lefp* start to decrease. That means the negative impact of economic growth on the environment at initial stages of economic growth turns to a positive one as countries become richer. Yet, the coefficients of income per capita for *lefm* are much higher than those for *lefp* indicating that that import footprint rises faster than production footprint as income increases. The turning points for income vary between 38,000 and 1.6 million USD (in constant 2000 prices). In the case of *lefm*, the turning point is far abovethe upper limit of the income range of the sample (see Table 1).

The effect of trade openness (*open*) is found to be positive in all the estimations. As the share of exports plus imports in total GDP increases, countries are expected to suffer from higher environmental pressure both at home and abroad. The coefficients are much higher for *lefm* in Eq. (3) and (4) (Table 2), which indicates that relatively open economies tend to export the environmental consequences of their economic activities.

As expected, having higher biocapacity per capita (*lbio*) tends to decrease import footprint as these countries can deplete their own resources and consume their own biological capacity. On the other hand, higher biocapacity implies higher footprint of production due to the same reasons.

Expectedly, denser population (*popden*) causes higher domestic production footprint. Yet, contrary to our expectations, we found a negative relationship between *lefm* and *popden*. A possible explanation is that, in densely populated regions, imported energy can be expected to be consumed more efficiently (thanks to i.e. central heating and the dense and highly connected transportation networks which reduce the need for private transportation).

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

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

Industry value added share in GDP (*ind*) appears to have a negative effect on *lefm.* Industrialization may lead to the production of goods domestically, which in turn reduces imports and thus footprint of imports.

Energy use per capita (*enpc*), on the other hand, bears a triggering effect on environmental pressure in terms of domestic production. Higher levels of energy use bring together depletion of more domestic resources and more production at home. However it has no significant effect on footprint of imports.

Finally, we have examined the implications of stringency of environmental regulation (*ereg*) and enforcement of environmental regulation (*enfo*) on the location of environmental pressure. The results indicate that as regulation becomes more stringent, footprint of domestic production decreases. On the other hand, as regulation enforcement becomes more rigorous, footprint of domestic production increases. Our findings are parallel to Cheng and Lai (2012) which argues that a stricter enforcement policy adds to the financial burden of polluting firms, which then leads these firms to exert higher political pressure to relax the environmental standards, consequently creating more environmental degradation.

However, stringency of environmental regulation and enforcement has no significant effect on footprint of imports. That is to say, domestic regulations related to environmental standards do not influence country decisions to import the environmentally harmful products from abroad; but they do affect domestic production characteristics.

It is noteworthy that income turning points change significantly once environmental regulation stringency and its enforcement are accounted for. For the case of *lefm*, threshold income drops down to around 320,000 USD (in constant 2000 prices) whereas for *lefp*, turning point income per capita decreases from 40,000 to around 38,000 USD when we include *ereg* and *enfo* variables. The fact that EKC relationship holds in the absence of regulation and enforcement variables hints that it is not a policy-induced relationship only. Environmental regulations are also important in determining the turning points.

5. Conclusion and Discussion

In today's world, it is an incontestable fact that increasing human consumption is a serious threat for the world's resources and environmental quality. As emphasized by credible international institutions and scientific research, global consumption is far beyond the Earth's biological capacity. This can clearly be seen in the consumption footprint of an average world citizen, which is equal to 2.7 gha as of 2008, whereas the available per capita biological capacity of the world is only 1.78 gha (GFN, 2010). If human beings insist on their current consumption patterns, we will need more than double the current equivalent of earth resources in the upcoming decades. These facts raise concerns about sustainability of consumption patterns, resource use and environmental quality.

Economic growth has been put forward as the key panacea to environmental problems in the contemporary world. The faith in this stems from the phenomenon that some developed countries have started to care about their environment, resources and sustainability after achieving high per capita income levels owing to the fact that they have attained cleaner technologies, more efficient production structures as well as increased environmental awareness of their citizens and stringent policies for environmental regulation in a democratic environment. The so-called EKC hypothesis generalizes this idea to different economic development levels in quest for increasing environmental pressure at low income levels and decreasing environmental pressure at higher income levels.

Various indicators have been used to account for environmental degradation and resource depletion in the search of a relationship with respect to changing income levels. One such indicator is the ecological footprint, which was developed by Wackernagel and Rees (1996).

This indicator measures the amount of biologically productive land required to support the consumption of renewable natural resources and assimilation of carbon dioxide emissions of a given population. In this study, we utilize the ecological footprint data due to two main reasons. First, we aim at a distinction in environmental pressure that is born at home country versus abroad. This helps us decouple the effects of consumption that originate from different production locations. Second, while standard EKC studies focus on a one-dimensional indicator of environmental quality (such as CO_2 emissions or solid waste), the ecological footprint serves as a multi-dimensional indicator that accounts for cropland, grazing land, fisheries, forestland, carbon footprint and built-up land. This mirrors our belief that environmental impacts of economic activity cannot be narrowed down to a single pollutant.

Previous literature suggests mixed evidence for the effects of economic growth on the environment. Some studies find EKC-type relationships characterized by an inverted U-shaped figure for income and pollution. Some others find no significant causality between the two indicators or either monotonically decreasing or increasing relationships. Yet, differences might arise from estimation methods and/or the characteristics of the data used.

It is not only income growth but also other properties of an economy that might lead to diverging patterns in environmental quality. For instance, international trade and foreign direct investments potentially influence what countries experience in terms of environmental effects. The implications could be such that developed countries start to import rather than domestically produce the goods which are ecologically damaging. This is framed by the so-called “Pollution Haven” and “Race-to-the-Bottom” hypotheses, which state that dirty industries relocate from developed to less developed countries since the latter are eager to lower their environmental standards in order to attract higher levels of investment and capital.

In an analysis of 105 countries for the year 2006, our results validate the EKC hypothesis for the relationship between income per capita and ecological footprint of imports and ecological footprint of production. Yet, in the case of footprint of imports, the estimated income turning points are out of the income range of the sample. This supports our hypothesis that as countries grow richer they tend to export the ecological cost of their consumption to poorer economies.

Second, our results indicate that trade openness, measured by the share of total trade in GDP, leads to higher import footprint and production footprint, confirming the findings of Andersson and Lindroth (2001).

As expected, countries that are richer in their biological stocks are found to bear lower import footprint since they are less dependent on imported goods. On the contrary, higher biocapacity implies higher footprint of production owing to the same reasons.

Higher share of industry in the economy is found to imply decreasing environmental pressure abroad. Higher energy use per capita, on the other hand, induces a higher ecological footprint as a result of domestic production. This meets our expectations, since energy use necessitates the extraction and utilization of domestic resources if a country is abundant with them.

We have investigated the implications of stringency and enforcement of environmental regulation on the location of the environmental pressure in our analysis. The results indicate that more stringent regulation leads to a decline in the footprint of domestic production. On the other hand, strictly-enforced regulation causes higher footprint of domestic production. However, stringency of environmental regulation and enforcement has no significant effect on footprint of imports. That is to say, domestic environmental regulations do not influence country decisions to import environmentally harmful products from abroad; but they do affect domestic production characteristics.

To sum up, given the diverging economic, environmental and political characteristics of countries, 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 support the view of Van Alstine and Neumayer (2010) that the “grow now, clean up later” message of standard EKC studies might be misleading for developing and less developed countries given the predictions that many countries will not reach EKC turning points for decades to come. The finding that countries tend to import environmentally damaging product from abroad as they get richer confirms our hypothesis that they export ecological cost of their consumption to poorer economies. Hence, the answer to the question in the title of this study is that income growth relocates ecological footprint. Increased volume of trade strengthens this result. Reminding the latest report of The Intergovernmental Panel on Climate Change (IPCC, 2013) on the science of global warming, human activity is to be blamed as the primary cause of not only climate change, but also other dimensions of environmental degradation that have been accounted for in the present study.

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Figure 1: Import and Production Footprints in 2006, per capita

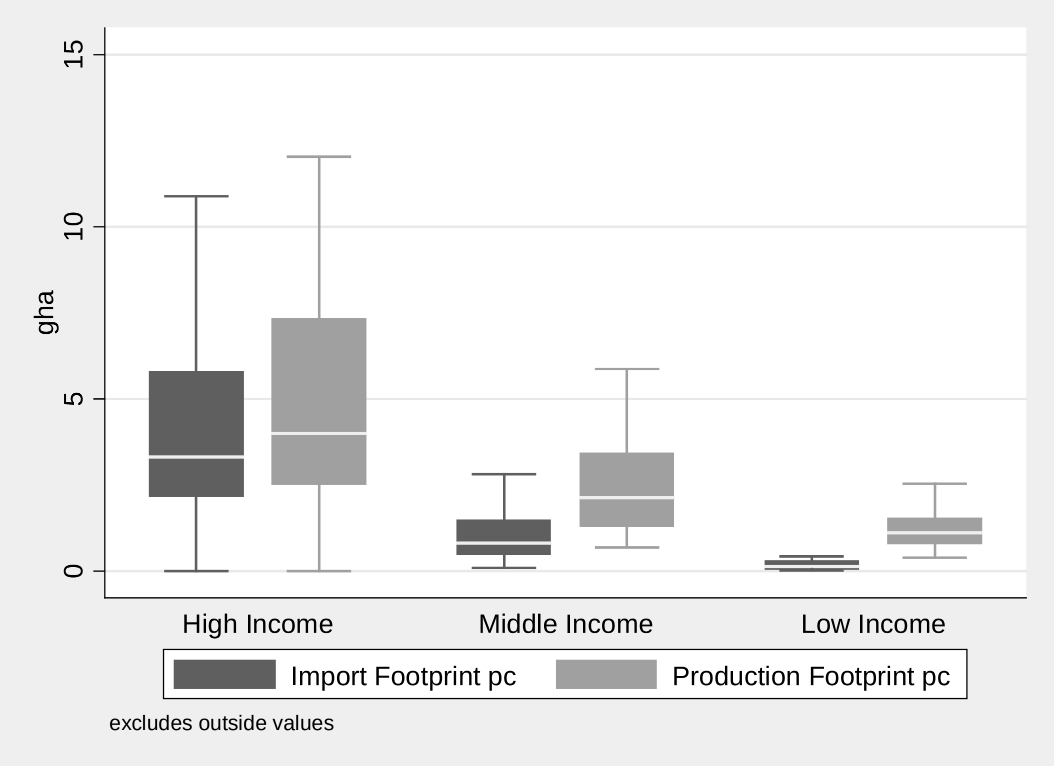
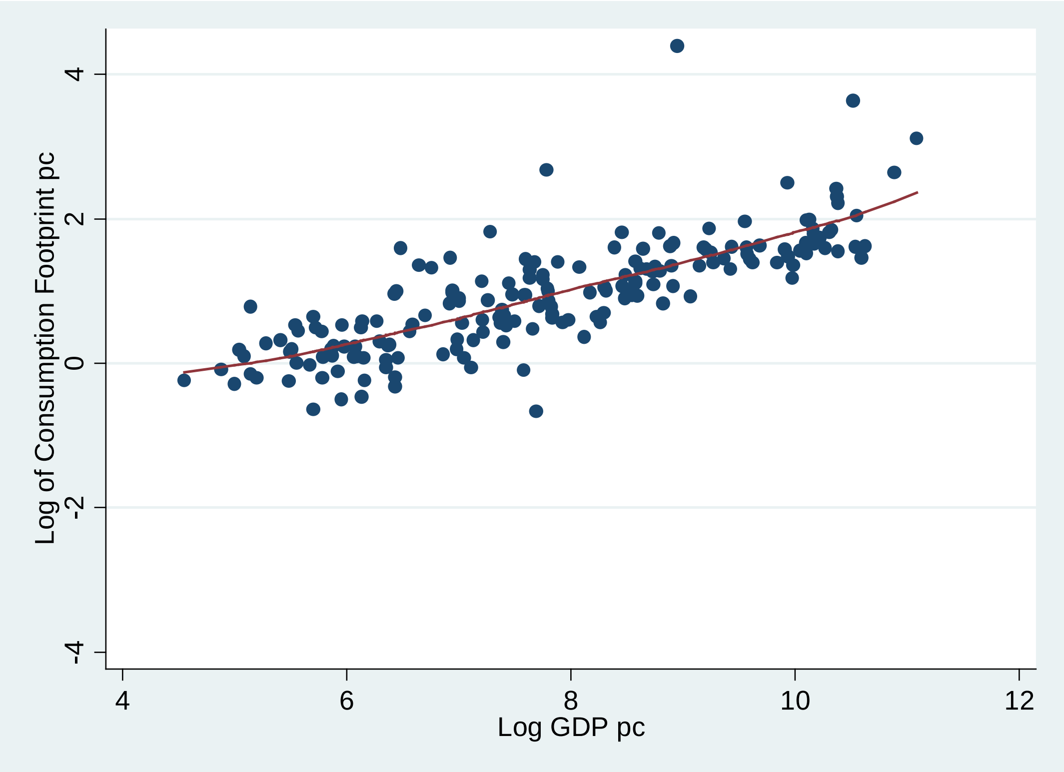
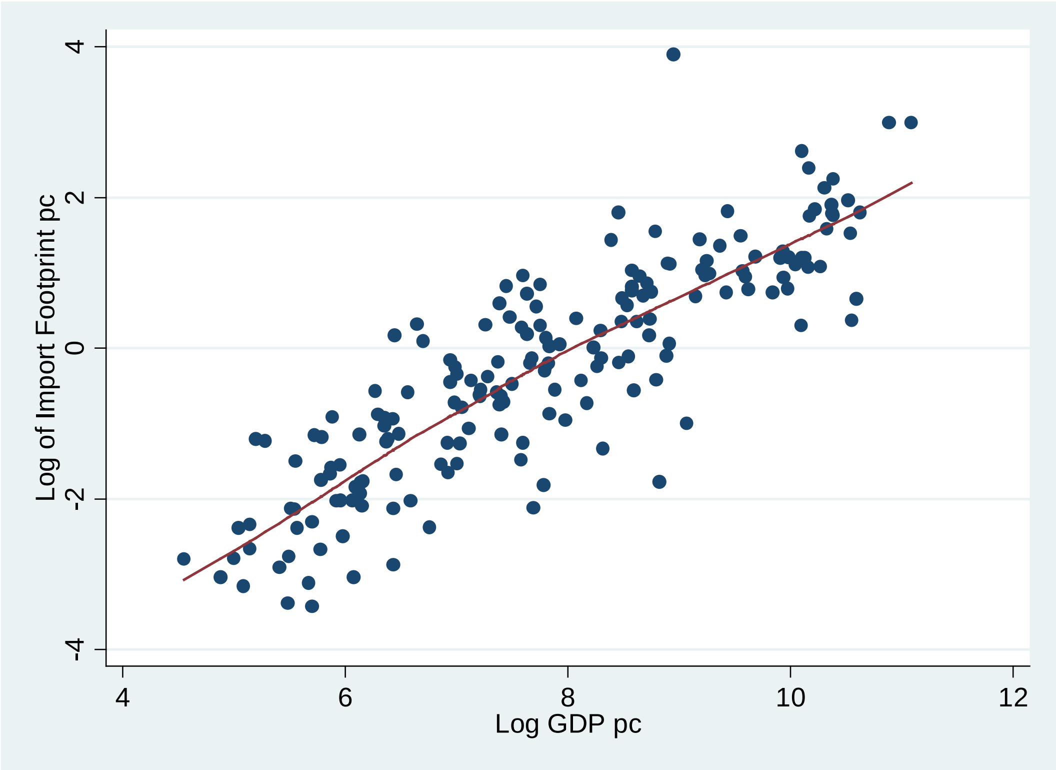


Figure 2: Consumption Footprint vs. GDP per capita, 2006



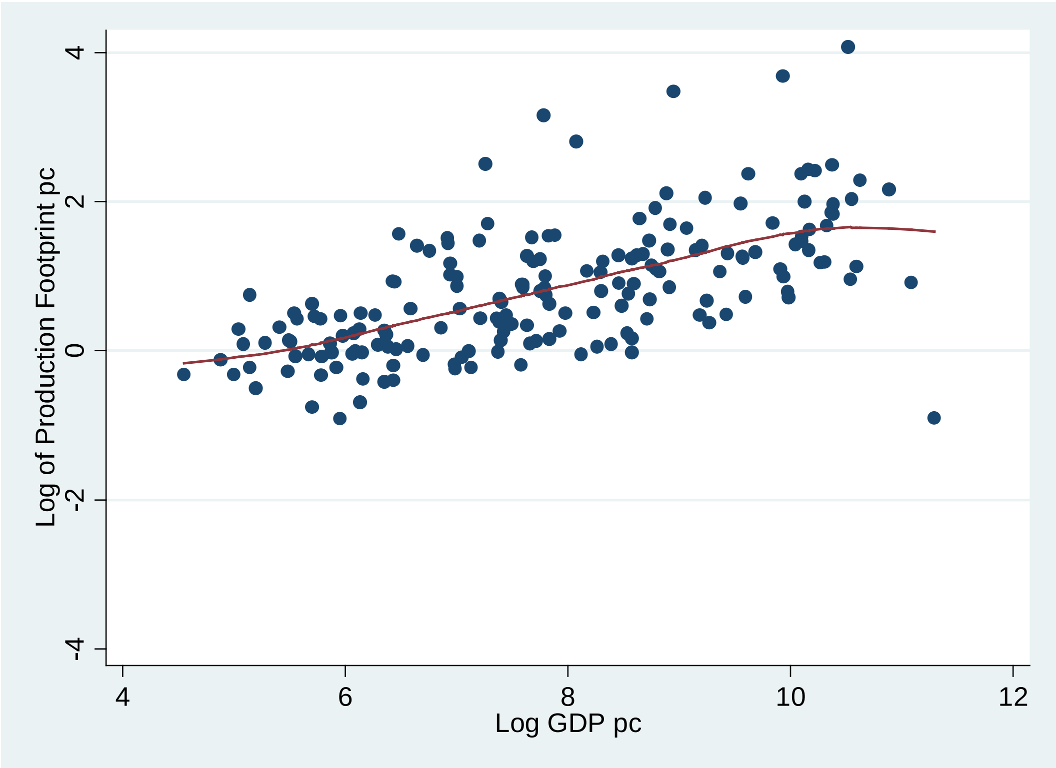
Notes: See Table A1 for data definitions. The line represents Lowess function estimated with a bandwidth of 0.8.

Figure 3. Import Footprint 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: Production Footprint vs. GDP per capita, 2006



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

Table 1: Descriptive Statistics

Variables	Mean	St. Dev.	Min	Max	N
Import footprint per capita	1.89	2.42	0.03	13.73	105
Production footprint per capita	2.99	2.43	0.50	11.34	105
GDP per capita	8,085	10,759	162	41,246	105
Openness to trade	93	50	26	437	105
Biological capacity	2.95	3.70	0.02	19.14	105
Population density	0.19	0.64	0.00	6.38	105
Industry share	0.32	0.11	0.13	0.79	105
Energy use per capita	2.10	1.86	0.01	8.24	105
Stringency of environmental regulation	3.98	1.06	2.28	6.41	105
Enforcement of environmental regulations	3.80	1.00	2.27	6.17	105

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

Table 2: IRLS Regression Results for Import Footprint, Production Footprint, and Import/Production Footprint, 2006

	(1) lefp	(2) lefp	(3) lefm	(4) lefm
lgdp	0.612***	0.756***	1.644***	1.867***
	(2.72)	(2.89)	(3.27)	(3.59)
lgdpsq	-0.0289**	-0.0358**	-0.0574*	-0.0737**
	(-2.11)	(-2.21)	(-1.85)	(-2.24)
open	0.154***	0.144***	1.128***	1.091***
	(3.09)	(3.11)	(6.78)	(6.23)
lbio	0.361***	0.368***	-0.136***	-0.137***
	(9.40)	(11.96)	(-3.06)	(-3.09)
popden	0.0961*	0.0939**	-0.613***	-0.610***
	(1.95)	(2.39)	(-5.43)	(-5.21)
ind	-0.173	-0.278	-1.040**	-0.987**
	(-0.87)	(-1.37)	(-2.34)	(-2.11)
enpc	0.166***	0.161***	0.0671	0.0648
	(6.30)	(5.89)	(1.58)	(1.50)
ereg		-0.278***		-0.221
		(-2.76)		(-0.96)
enfo		0.263**		0.324
		(2.42)		(1.44)
constant	-2.817***	-3.355***	-10.14***	-11.18***
	(-3.16)	(-3.16)	(-5.19)	(-5.33)
N	105	105	105	105
R^2 (w)	0.91	0.92	0.89	0.89
turning points	40,196	37,894	1,649,263	318,842

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

Appendix

Table A1: Data Units and Sources

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