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role of environment intensity, income and interaction
effects

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Ecological Footprint Inequality across countries: the role of environment intensity, income and interaction effects

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Abstract

Recently, White (2007) analysed the international inequalities in Ecological Footprints per capita (EF hereafter) based on a two-factor decomposition of an index from the Atkinson family (Atkinson (1970)). Specifically, this paper evaluated the separate role of environment intensity (EF/GDP) and average income as explanatory factors for these global inequalities. However, in addition to other comments on their appeal, this decomposition suffers from the serious limitation of the omission of the role exerted by probable factorial correlation (York et al. (2005)). This paper proposes, by way of an alternative, a decomposition of a conceptually similar index like Theil's (Theil, 1967) which, in effect, permits clear decomposition in terms of the role of both factors plus an inter-factor correlation, in line with Duro and Padilla (2006). This decomposition might, in turn, be extended to group inequality components (Shorrocks, 1980), an analysis that cannot be conducted in the case of the Atkinson indices. The proposed methodology is implemented empirically with the aim of analysing the international inequalities in EF per capita for the 1980-2007 period and, amongst other results, we find that, indeed, the interactive component explains, to a significant extent, the apparent pattern of stability observed in overall international inequalities.

Key words: ecological footprint; international environmental distribution; inequality decomposition

1. Introduction

The concept of ecological footprint has received a great deal of attention in the literature on the environment. The Ecological Footprint (EF hereafter), introduced by Rees (1992) and developed by Wackernagel and Rees, (1996), addresses the use of resources associated with productive and human activities, homogenizing it based on the amount of bioproductive land necessary to produce the required resources¹. In this respect, an interesting analysis would be to examine the international distribution of this indicator as an exercise to compare the level of equality in the use of resources between countries, in a context of limitations on the planet's biocapacity and the accelerated growth in consumption. This analysis, which has already been done by authors such as White (2007) and Dongjing et al (2010) in an international context², would appear to be more comprehensive than the typical analyses that focus on partial environmental indicators such as CO₂, energy intensities or local pollutants.

In particular, an interesting analysis in the context of an international distributive analysis of this measurement, would be one that evaluates the role of environmental intensity (i.e. EF/GDP), and level of affluence as explanatory factors of global inequalities in EF, following in the wake of the IPAT model and the Kaya identity (Kaya (1989)). In particular, intensity is seen as an indicator of environmental efficiency, by relating the volume of productive and human activity with the associated need for resources (York et al. (2005)). In this context, White (2007) suggests decomposing an index such as Atkinson's with an inequality aversion parameter equals to 1 (Atkinson (1970)) in the multiplication of individual factorial indices (hence associated with environmental intensity and average income) and a component that covers

¹ The EF has been adopted by a growing number of government authorities, agencies and policy makers as a measure of ecological performance. Noteworthy examples are those international applications such as the European Environment Agency (EEA (2010), the European Parliament and the European Commission (Best et al, 2008), who consider the EF to be a useful tool for measuring the environmental performance of the EU, or the United Nations Development Programme which considers EF as capturing the environmental dimension of human development (UNDP, 2010).

² Also Wu and Xu (2010), for example, are conducting the analysis for the Chinese provinces.

factorial averages. Hence, among other aspects worth noting, this decomposition does not precisely consider the role that might be played by the probable correlation between the two factors, which has already been clearly documented by York et al (2005). In this way, the factors included in White's (2007) exercise, or one of them, appear as a type of black box that can contain both the partial impacts and the indirect impacts arising from the interactions between them and, consequently, the decomposition seems rather ambiguous.

In view of these circumstances, this paper proposes the usefulness of alternatively decomposing an index such as the Theil index (Theil (1967)), which is cardinally equivalent to the Atkinson index mentioned earlier, which can, indeed, be decomposed (in an additive way, furthermore) in the partial contribution of both factors (intensity and GDP per capita) plus a factorial interaction component. This decomposition can be immediately extended with the aim of analysing the group inequality components (Shorrocks (1980)). This paper also undertakes an empirical illustration of this proposed decomposition in order to analyse the international inequalities in EF per capita during the 1980-2007 period and the group inequality components according to the regionalization criteria adopted by the IEA, which contemplates nine world regions. Among the early results obtained is the fact that the apparent stability of the international inequalities in EF per capita are explained to a large extent by the effect of the interactive component, without which the global inequalities would have been significantly smaller.

This paper is therefore structured as follows: the second section addresses the main methodological elements of the proposed decomposition. The third section presents the main findings obtained after applying this methodology to the analysis of inequalities in EF per capita during the 1980-2007 period. Finally, a section is devoted to summarizing the main conclusions drawn from this analysis.

2. Ecological footprint inequalities and the role of environment intensities, income and interaction effects: methodological aspects

One of the most interesting approaches designed to investigate the explanatory factors behind ecological footprint by country consists of breaking down, by multiplication, their level of intensity in the use of resources and the average income (York et al. (2005)):

$$e_i = \frac{E_i}{P_i} = \frac{E_i}{Y_i} * \frac{Y_i}{P_i} = I_i * y_i \quad (1)$$

where E is the ecological footprint of country i; P is its population and Y is its GDP; e is the ecological footprint per capita; I is the environmental intensity factor, and y is the GDP per capita.

Thus the use of resources per capita would be broken down in the part associated with intensity of use and global economic activity (i.e. the scale effect). In the first case, its importance would be associated with factors such as environmental efficiency.

In this respect, and with the aim of evaluating the inequalities in EF and the role of the two previous multiplicative components, White (2007) used the Atkinson index (Atkinson (1970)), with an inequality aversion parameter equals to 1³. Specifically, the aversion parameter used would indicate the presence of a progressive-type inequality index (sensitive to changes in the lower part of the distributive ranking by countries) but not extreme (Atkinson (1970)). To be specific, this index would be expressed as follows (already adapted to the analysis of the ecological footprint per capita in his notation):

$$A(e) = 1 - \Pi_i \left(\frac{e_i}{\mu^e} \right)^{p_i} \quad (2)$$

where μ^e is the global average of e; and p_i is the relative population of country i

³ The use of an index from the Atkinson family is slightly surprising, given the objective difficulties in decomposing it in parts (Bourguignon (1979)).

Replacing (1) by (2) and manipulating the equation, we find that:

$$1 - A_e = \left(\frac{\mu_i * \mu_y}{\mu_e} \right) * \Pi_i \left(\frac{y_i}{\mu^u} \right)^{p_i} * \Pi_i \left(\frac{I_i}{\mu^I} \right)^{p_i} \quad (3)$$

And thus White (2007) established that:

$$1 - A_e = \left(\frac{\mu_i * \mu_y}{\mu_e} \right) * (1 - A_y) * (1 - A_i) \quad (4)$$

where $1 - A_e$ would be an equality index (according to the author); μ^I the global average of environmental intensities, and μ^y the average global income.

However, if we analyse this in detail, it is not difficult to see that the last multiplication of (3) is not exactly an Atkinson index. Indeed, if it were, the weight vector would have to be consistent with the actual variable analysed, in this case the environmental intensity. This is indeed the case for $1 - A_y$, where the weighting in the expression (3) comes from population-shares. In the case of $1 - A_i$ the weightings of the differences across countries should, if we are talking about the Atkinson index in the strictest sense, be done based on GDP-shares. This is not a trivial difference. Indeed, it is plausible that, on an empirical level, the value of this pseudo-Atkinson index could reach negative signs, which would indicate that it contains factorial correlation components. In this way, therefore, one of the components detailed in the decomposition, i.e. $1 - A_i$, is not strictly speaking an Atkinson index and, moreover, the factorial correlation is not individualized.

In this respect, it would be interesting to have a decomposition which: firstly, decomposes the global index in a series of strict inequality indices (or partial factorial contributions) for each of the factors; secondly, it would be interesting if

the decomposition were to include, separately, the role of the factorial correlation; thirdly, it would be good for the decomposition of inequality to be additive, as is the case with other more familiar decompositions of inequality indices⁴.

In these circumstances, we suggest the usefulness of using an alternative decomposition technique for an index such as Theil's second measure, or $T(\beta=0)$ (Theil (1967)), which is easier to decompose than the Atkinson index mentioned earlier and, in fact, would achieve analogue distributive rankings to the Atkinson index with a sensitivity parameter equals to 1⁵. In particular, as is well known, this Theil index ($\beta=0$) (hereinafter referred to as T) would be calculated based on the following formula (now adapted to the analysis of inequalities in the ecological footprint per capita):

$$T_e = \sum_{i=1}^n p_i \ln \left(\frac{\mu^e}{e_i} \right) \quad (5)$$

where p_i is the relative population of country i ; μ^e would represent the world ecological footprint per capita; e_i denotes the ecological footprint per capita of country i and \ln is the Neperian logarithm.

This index could demonstrate that it is a growing monotonic transformation of the Atkinson index with $\varepsilon=1$ (i.e., $A(1)$), used referentially by White (2007) in the following form:

$$T = -\ln(1 - A(1)) \quad (6)$$

The minimum value that this Theil index could hypothetically reach is zero, a circumstance that would describe a scenario of absolute equality. The maximum value is not uniformly defined but depends on the specific details of

⁴ This would be the case of decomposition by groups (Shorrocks (1980))or by sources (Shorrocks (1982)).

⁵ Duro and Padilla (2006) applied a similar methodology to analyse international inequalities in per capita carbon emissions but in a three-factor scenario.

each case. However, a figure close to one could be understood as being synonymous with high inequality. Meanwhile, you can see that this measure is not defined by values equal to zero, a circumstance which, however, is unlikely in the analysis in question.

The decomposition of the inequalities in ecological footprint per capita measured by this index would start with the initial factorial decomposition expressed in (1). We now need to define two fictitious national ecological footprint vectors. According to Duro and Padilla (2006), in each case we allow only one of the factors to vary, setting the other at the global average. We would then find that:

$$e^I = I_i * y \quad (7)$$

$$e^y = I * y_i \quad (8)$$

If we apply the Theil index, according to formula (5) for each of the fictitious factors above, we would be measuring the partial role of each of these factors.

This being the case, we would find that:

$$T(e^I) = \sum_i p_i \ln \left(\frac{\mu(e^I)}{e_i^I} \right) \quad (9)$$

$$T(e^y) = \sum_i p_i \ln \left(\frac{\mu(e^y)}{e_i^y} \right) \quad (10)$$

If we add both factors, we find that:

$$T(e^I) + T(e^y) = \sum_i p_i \ln \left(\frac{\mu(e^I) * \mu(e^y)}{e_i^I * e_i^y} \right) = \sum_i p_i \ln \left(\frac{\mu(e^I)}{y * I_i} * \frac{I \sum_i p_i * y_i}{I * y_i} \right) = \sum_i p_i \ln \left(\frac{\mu(e^I)}{I_i} * \frac{y}{y_i} \right) \quad (11)$$

We can now see that if we add the term $\ln\left(\frac{\mu}{\mu(e^I)}\right)$ to the previous total and group them, we find that:

$$\begin{aligned} T(e^I) + T(e^y) + \ln\left(\frac{\mu}{\mu(e^I)}\right) &= \sum_i p_i \ln\left(\frac{\mu(e^I) * y}{I_i y_i}\right) + \ln\left(\frac{\mu}{\mu(e^I)}\right) = \sum_i p_i \ln\left(\frac{\mu(e^I) * y * \mu}{I_i y_i \mu(e^I)}\right) = \sum_i p_i \ln\left(\frac{\mu(e^I) * y * \mu}{I_i y_i \mu(e^I)}\right) = \\ &= \sum_i p_i \ln\left(\frac{e}{e_i}\right) = T(e) \end{aligned} \quad (12)$$

It is easy to corroborate that, indeed, this added component can be rewritten in terms of a covariance component term between both homogenized factors. Thus, it can be easily demonstrate that⁶:

$$\ln\left(\frac{\mu}{\mu(e^I)}\right) = \ln\left(1 + \frac{\sigma_{I,y}}{\mu(e^I)}\right) \approx \frac{\sigma_{I,y}}{\mu(e^I)} \quad (13)$$

This being the case, the final outcome would be that the international inequalities in ecological footprint per capita could be decomposed strictly in terms of the sum of the partial factor's contribution and the correlation factor:

$$T(e) = T(e^I) + T(e^y) + \ln\left(1 + \frac{\sigma_{I,y}}{\mu(e^I)}\right) \quad (14)^7$$

⁶ Demonstration available from the author on request

⁷ Thus one could consider decomposing, analogously, the first Theil measurement, or $T(\beta=1)$ (Theil (1967)). This measurement is characterised by weighting the differences based on the share dictated by the numerator, in this case the EF-share per country. Given that the only difference between this index and the $T(\beta=0)$, which has been proposed in the main text, is also the weighting vector and the position of variables within the logarithm we would immediately seem to be trying to decompose this measure too. However, in this case the decomposition is much less natural and attractive than that of the $T(0)$, expressed in (14). In particular, the problem is that the term we have called 'factorial interaction' is, in this case, a type of adjustment component with a much less attractive meaning than that of the $T(0)$. In particular, it can be demonstrated that:

Likewise, this decomposition can be easily extended to the analysis of the intra- and inter-group components of the global international inequality. These components, as we know, emerge from the capacity of this index to break down into a weighted average the inequalities inside the subgroups under observation (intra-group or internal component) and the inequality shown between the subgroups (inter-group or external component) (Shorrocks (1980) and Bourguignon (1979)). We would thus need to select a criterion to demarcate the groups of countries which would be intuitive and, a priori, relevant. An immediate option is the use of the International Energy Agency aggregations which identify nine main regions. The implications that emerge from this analysis by groups could be interesting. For example, in terms of environmental policy, the findings would offer clues as to the suitability of implementing re-balancing policies in terms of a global regional design. On the other hand, from a more academic point of view, the results might be used to test the informative value of the aggregations themselves. Thus a high value in the intergroup component (or a small one in the intragroup one) would be perceived as an endorsement of the proposed regional synthesis.

In algebraic terms, the decomposition by T(0) groups would be expressed by the following formula:

$$T(e) = T(e)_W + T(e)_B = \sum_{i=1}^G p_g T_g(e) + \sum_{g=1}^G p_g \ln \left(\frac{\mu^e}{e_g} \right) = \sum_{i=1}^G p_g T_g(e) + T(e_g) \quad (15)$$

where $T(e)_W$ is the intragroup component and $T(e)_B$ is the intergroup component; g refers to country groups; p_g and y_g are the relative population

$$T_1(e) = T_1(e^I) + T_1(e^Y) + \ln \left(\frac{\sum \alpha_i * e_i - \sigma_{I,Y}}{\mu} \right)$$

where α_i is the EF-share

In this way, the additional term depends inversely on the covariance as well as an element that reflects a pseudo-global EF per capita average when using the EF-share instead of the population-share.

and the average EF corresponding to the g group, respectively, and $T_g(e)$ is the inequality between countries in the g group.

This being the case, and given the expression that takes both components, it is worth looking at breaking them down immediately in the form suggested in (14). Note that the intergroup component is none other than a Theil index, in this case applied to the groups of countries as basic units of the study. The intragroup component, meanwhile, is a weighted average of regional Theil indices which, in turn, can be decomposed multiplicative form above. In particular, the decomposition of the group components would come out as shown below:

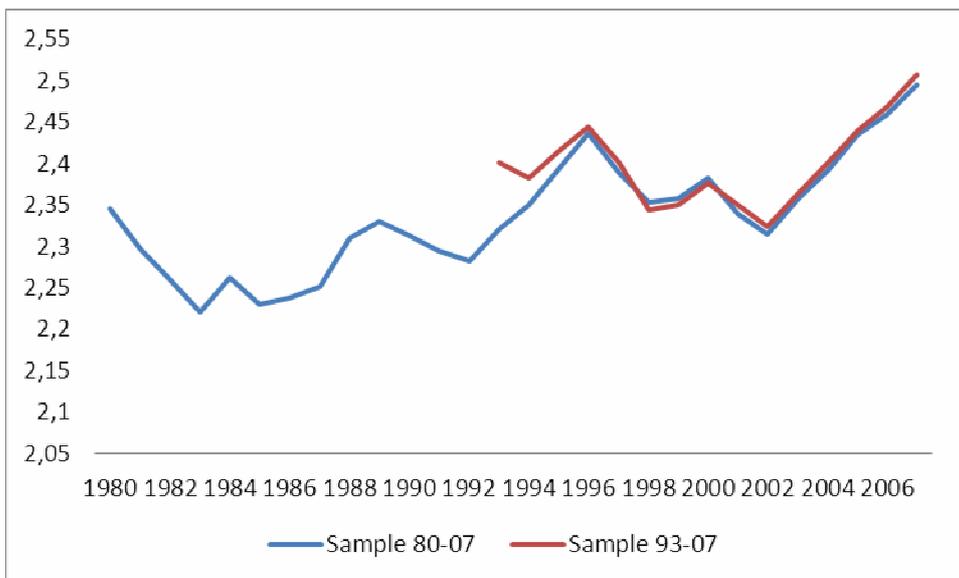
Up to now, so far as we are aware, two studies have been conducted in the international sphere to examine inequalities in EF per capita. White (2007), for example, examined them using the Gini coefficient and the Atkinson index, but only for 2003, and also decomposed the latter, as we have seen, by multiplication factors. Dongjing et al (2010), meanwhile, analysed these inequalities by taking the Gini coefficient as a benchmark measurement of inequality for selected years during the 1996-2005 period. In our particular case, therefore, we are focusing on a specific methodological aspect, the decomposition of inequalities, by multiplication and by groups, and undertaking an empirical analysis over a longer period of time.

3. Main Empirical Results

The data used came from the Global Footprint Network in the case of the Ecological Footprint by country, and from the World Bank (World Bank Indicators) for the GDP and population factors. The joint analysis of the available variables made it advisable to differentiate two periods of time for the samples. The first included 105 countries during the 1980-2007 period, which together accounted for almost 80% of the World Ecological footprint generated in 2007. In the second, the analysis was restricted to the period of 1993-2007, which allowed us to use data for 136 countries generating 89% of the World Ecological footprint of 2007.

First and foremost, in the contextual period there has been a gradual increase in the EF per capita at a global level, rising from 2.23 in 1985 to 2.49 in 2007, i.e. an increase of just over 10%. There was a slight drop between 1980 and 1985 and a global tendency to rise since then, with ups and downs. The use of the 1993-2007 sample did not produce any significant changes either to the time pattern or the overall level of the world EF per capita.

Figure 1: Evolution of the world EF per capita, 1980-2007



Source: Drawn up by the authors using Global Footprint Network and World Bank data

Table 1 shows the main results obtained after decomposing the international inequalities in EF per capita, taking the Theil index as a reference and for selected years in the different periods. In this respect, the main results can be summed up as follows:

Firstly, for the aggregate period the international inequalities would have dropped, especially up to 1995. Between 1995 and 2007 there is barely any variation⁸. Indeed, we cannot conclude that there is a substantial variation in an almost thirty-year period (plus or minus 10%). This finding, for example, is lower than the reduction experienced in international inequalities in CO₂ per capita, which over the 1971-2006 period was 38%, or those reflected by energy intensities, whose inequalities were mitigated by 45% since 1971 (Duro (2012)).

Secondly, however, both the partial contribution to global inequality attributable to the intensity factor and to the affluence factor (which is the most important factor) drop significantly, especially the second one, thus leading to a broad reduction in global EF inequalities per capita. Thus the partial disparities attributable to the intensity factor drop from 0.37 in 1980 to almost 0.21 in 2007 (a reduction of almost 50%). The income factor, meanwhile, which maintains a relatively larger contribution, sees its contribution reduced from 1.03 in 1980 to 0.60 in 2007 (a drop of almost 40%). The drop in the intensity factor takes place essentially up to 2000, after which it becomes stable. However, the income factor drops throughout the whole period.

Thirdly, given the significantly equalizing contribution of the abovementioned factors, the interaction factor is the one which, in effect, explains the less clear-cut result seen in the evolution of international inequalities in EF per capita.

⁸ In this paper we have focused on the evidence provided by the Theil index as a reference indicator of inequality. This is because the paper focuses on the investigation of the role of environmental intensity and affluence as explanatory factors and, therefore, in a context of multiplicative decomposition. This being the case, it does not reflect the results obtained from using other inequality indices that are not easy to decompose in this context. In any event, the calculation of indices such as the Gini, the Atkinson ones and the Coefficient of Variation (following Duro (2012) does not throw up any particularly significant changes to the time pattern of international inequalities in EF per capita. These calculations are available on request.

Thus factorial interaction plays a significant role, with a negative sign⁹. Indeed, its value is similar to that of affluence, with a changed sign. And it is the significant drop in the value of this component (less the negative sign) which explains the lower drop in global inequalities. Without this contribution, i.e. with a hypothetical zero interaction factor, the international inequalities in EFP per capita would have dropped from an imaginary 1.4 in 1980 to 0.81 in 2007.

Meanwhile, we have taken advantage of the decomposition facilities of $T(0)$ to decompose by multiplication the global inequalities by group components (Shorrocks (1980)). In other words, we have initially decomposed the global inequality in EF per capita into two parts: the first, the one attributed to the differences between groups of countries when these are regional, and secondly the one attributed to the scale of the internal heterogeneities of the groups in accordance with the regionalization criteria used by the IEA. The point is that each of these synthetic components is thus decomposable based on the previous multiplicative format. Table 2 shows the results associated with the between-groups component, and Table 3 shows those associated with the within-groups component.

With regard to the between-groups inequality, we can see the following basic results: firstly, it is the between component which has the greater explanatory power of global inequalities in EF per capita. In fact, its weight is typically close to 80% of the total, when not exceeding it. This weight illustrates, amongst other aspects, the explanatory capacity of these exogenous groups for the EF pc inequalities as well (Duro and Padilla (2006)). Secondly, it also confirms the not very substantial drop in global inequalities accompanied by the larger drop in individual factorial inequalities, especially in the affluence factor. Thirdly, it confirms the high incidence of the interaction component and its particular influence on the apparent stability of the between component of global inequality. Indeed, the interaction component, with a negative sign, declines

⁹ The factorial correlation coefficient typically moves between -0.37 and -0.48 in the case of the 1980-2007 sample, and between -0.43 and -0.49 in the case of the 1993-2007 sample. More detailed information is available on request.

significantly, which considerably contributes to offsetting the drop in individual factorial inequalities.

Finally, with regard to the within component, this has a lower overall weight in the explanation of global inequalities, reaching maximum explanatory values of around 20% of the total. In this case, the pattern outlined is different from that of the between component. For example, in this case the inequalities rose during the period, explained by the evolution in both factors. In contrast, the interactive component now increases its negative value in the 1971-2007 sample, contributing to reducing the inequalities, and remains stable in the sample that starts in 1993.

Table 1: International inequalities in the Ecological Footprint per capita and its decomposition by multiplication factors, 1980-2007

	T(e)	T(e ^I)	T(e ^V)	Interact term
1980	0.2764	0.3714 (134%)	1.0261 (371%)	-1.1212 (-406%)
1985	0.2726	0.2869 (105%)	0.9309 (341%)	-0.9452 (-347%)
1990	0.2676	0.2493 (93%)	0.8838 (330%)	-0.8655 (-323%)
1995	0.2459	0.2197 (89%)	0.7769 (316%)	-0.7507 (-305%)
2000	0.2591	0.2043 (79%)	0.7378 (285%)	-0.6829 (-264%)
2005	0.2622	0.2057 (78%)	0.6470 (247%)	-0.5905 (-225%)
2007	0.2445	0.2056 (84%)	0.6043 (247%)	-0.5654 (-231%)
1993	0.2433	0.2457 (101%)	0.7896 (325%)	-0.7920 (-326%)
1995	0.2398	0.2313 (96%)	0.7576 (316%)	-0.7490 (-312%)
2000	0.2485	0.2144 (86%)	0.7259 (292%)	-0.6918 (-278%)
2005	0.2522	0.2179 (86%)	0.6428 (255%)	-0.6084 (-241%)
2007	0.2387	0.2128 (89%)	0.6038 (253%)	-0.5779 (-242%)

Source: Drawn up by the authors using Global Footprint Network and World Bank data

Table 2: Between-groups Inequalities in Ecological Footprint per capita and their decomposition by multiplication factors, 1980-2007

	$T(e)_B$	$T(e^I)_B$	$T(e^Y)_B$	Interaction term
1980	0.2350 (85%)	0.3411 (145%)	0.9341 (397%)	-1.0402 (-443%)
1985	0.2313 (85%)	0.2313 (100%)	0.8365 (362%)	-0.8365 (-362%)
1990	0.2255 (84%)	0.1942 (86%)	0.7821 (347%)	-0.7508 (-333%)
1995	0.1972 (80%)	0.1285 (65%)	0.6588 (334%)	-0.5901 (-299%)
2000	0.2146 (83%)	0.0886 (41%)	0.6221 (290%)	-0.4961 (-231%)
2005	0.2143 (82%)	0.0666 (31%)	0.5316 (248%)	-0.3838 (-179%)
2007	0.1950 (80%)	0.0598 (31%)	0.4889 (251%)	-0.3537 (-181%)
1993	0.1960 (81%)	0.1478 (75%)	0.6647 (339%)	-0.6166 (-315%)
1995	0.1892 (79%)	0.1199 (63%)	0.6261 (331%)	-0.5568 (-294%)
2000	0.2031 (82%)	0.0865 (43%)	0.5975 (294%)	-0.4808 (-237%)
2005	0.2041 (81%)	0.0685 (34%)	0.5158 (253%)	-0.3802 (-186%)
2007	0.1886 (79%)	0.0615 (33%)	0.4774 (253%)	-0.3503 (-186%)

Source: Drawn up by the authors using Global Footprint Network and World Bank data

Table 3: Within-groups Inequalities in Ecological Footprint per capita and their decomposition by multiplication factors, 1980-2007

	$T(e)_w$	$T(e^l)_w$	$T(e^y)_w$	Interaction term
1980	0.0414 (15%)	0.0624 (151%)	0.0920 (222%)	-0.1130 (-273%)
1985	0.0413 (15%)	0.0627 (152%)	0.0945 (229%)	-0.1158 (-280%)
1990	0.0421 (16%)	0.0607 (144%)	0.1017 (242%)	-0.1203 (-286%)
1995	0.0487 (20%)	0.0648 (133%)	0.1182 (243%)	-0.1343 (-276%)
2000	0.0446 (17%)	0.0676 (152%)	0.1157 (260%)	-0.1388 (-311%)
2005	0.0479 (18%)	0.0747 (156%)	0.1155 (241%)	-0.1423 (-297%)
2007	0.0495 (20%)	0.0766 (155%)	0.1153 (233%)	-0.1424 (-288%)
1993	0.0473 (19%)	0.0769 (163%)	0.1249 (264%)	-0.1545 (-327%)
1995	0.0506 (21%)	0.0757 (150%)	0.1315 (260%)	-0.1566 (-310%)
2000	0.0454 (18%)	0.0703 (155%)	0.1284 (283%)	-0.1534 (-338%)
2005	0.0482 (19%)	0.0764 (159%)	0.1270 (264%)	-0.1553 (-322%)
2007	0.0501 (21%)	0.0774 (155%)	0.1264 (252%)	-0.1537 (-307%)

Source: Drawn up by the authors using Global Footprint Network and World Bank data

4. Concluding Remarks

This paper explores the international inequalities in the Ecological Footprint per capita, an indicator that has proved very popular in recent years as being representative of the use of resources associated with productive and human activities. In particular, this work makes two essential contributions, one methodological and the other empirical.

Firstly, it proposes a decomposition of international inequality in this indicator by multiplication factors, i.e. by separating the effect of intensity of use and affluence, which we believe surpasses the decomposition proposed for an index such as the Atkinson index by White (2007). In particular, the proposed decomposition not only allows us to identify the partial role played by each factor individually, but also to include an interaction factor, already referred to as significant by York et al (2005) though not contemplated by White (2007). Furthermore, the proposed decomposition (for the Theil index) can be extended to the group inequality components (Shorrocks (1980)).

Secondly, the paper makes an empirical implementation of the proposed analysis in order to examine the international inequalities in EF per capita for the 1980-2007 period (and increasing the analysis period of the existing literature). Amongst other findings, the evidence suggests that the apparent stability of, or lower reduction in, the international inequalities in EF per capita is attributed, to a large extent, to the role of the interaction factor, given that the contribution of the two multiplication factors that explain it (intensity of use and affluence) would have dropped significantly. Meanwhile, an analysis of the inequality by groups of countries suggests that it is the inequality component between groups (regional) of countries that primarily explains the global results and also that the nine regions considered (according to International Energy Agency classification) may be relevant not only descriptive but also in terms of policy

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Appendix

Countries included into groups:

OECD-Europe: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom.

OECD-NA: Canada, Mexico, United States.

OECD-Pacific: Australia, Japan, Korea, New Zealand.

Non-OECD Europe countries: Albania, Bulgaria, Cyprus, Gibraltar, Malta, Romania, Former USSR, Former Yugoslavia

Africa: Algeria, Angola, Benin, Cameroon, Congo, Democratic Republic of Congo, Côte d'Ivoire, Egypt, Ethiopia, Gabon, Ghana, Kenya, Libya, Morocco, Mozambique, Nigeria, Senegal, South Africa, Sudan, United Republic of Tanzania, Togo, Tunisia, Zambia, Zimbabwe, Other Africa

Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela, Other Latin America.

Middle East: Bahrain, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen

Asia: Bangladesh, Brunei Darussalam, Chinese Taipei, India, Indonesia, Dem. People's Rep. of Korea, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam, Other Asia.

China: People's Republic of China, Hong Kong.