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Abstract

While the relationship between environmental pressures and globalization is often claimed to be unambiguously positive, there is a substantial gap in the literature regarding systematic evidence. We fill this gap by empirically disentangling the nexus between globalization and environmental degradation while at the same time taking the multidimensionality of the concepts serious. The Ecological Footprint (EF) provides a holistic approach to environmental degradation. We generate a data set covering 146 countries over the 1981-2009 period and use an Extreme Bounds Analysis (EBA) to identify a robust set of controls testing different claims of the literature. Subsequently, we test our hypothesis regarding globalization controlling for this vector of controls. Our findings suggest that the simple positive correlation has to be interpreted with care, since the multivariate analysis reveals a more detailed picture of the complex relationship.

Keywords: Ecological Footprint; Globalization; EBA; Global environmental change

JEL: Q57, F64, O13

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1. Introduction

"A long term correlation between the recent processes of globalization of international markets and environmental degradation is quite evident [... and ...] so uncontroversial that, for the sake of brevity, we do not need to document it here."

(Borghesi & Vercelli, 2003)

According to Borghesi and Vercelli there seems to be no doubt about the degrading impact of economic globalization on the global environment. Scholars from various disciplines acknowledge that there is a connection between globalization and the (global) environment, yet, empirical evidence is largely missing. However, this hides the fact that the true relationship may be more complex. The objective of the paper is to close this gap and provide a comprehensive analysis of what drives human environmental demands taking the multidimensionality of globalization into account.

Broadly defined, globalization is *"the growing interconnectedness and inter-relatedness of all aspects of society"* (Jones, 2010). Previous work on the relationship between environmental pressures and globalization in many cases assesses one single dimension of globalization such as the level of trade openness and focuses on singular aspects of human demands and environmental pollutants (Antweiler, Copeland, & Taylor, 2001; Cole, 2004; Dreher, Gaston, & Martens, 2008; Lamla, 2009; York, Rosa, & Dietz, 2003a). In both cases the complexity of the concepts is neglected. However, for some time now, multi-dimensional and more holistic indicators of both phenomena provide the possibility to systematically assess the complex relationship and to investigate whether globalization has an unambiguously increasing effect on human demands on the environment.

Currently the most widely used measure for human ecological demands is the Ecological Footprint (EF) (Wackernagel & Rees, 1996). While we draw on previous research on the drivers of ecological pressures and human demands, we contribute new insights by first, considering a variety of determinants and identifying whether they are robust to including other conditioning variables.[1] For that we apply a variant of the Extreme Bounds Analysis (EBA) suggested by Sala-i-Martin (1997), Sturm and De Haan (2005) and Gassebner, Lamla, and Sturm (2011) and test 30 demographic, economic, geographic, cultural and political variables that have been suggested to affect ecological demands and pressures. This connects to the recent work of Teixidó-Figueras and Duro (2015)who investigate the drivers of EF inequalities across generation.[2] Second, we

[1] In their book on the consequences of globalization Dreher et al. (2008) analyze the influence of the globalization index on air and water pollution and also distinguish between the three dimensions of globalization. However, they focus on contemporaneous effects and do not consider human ecological pressures.

[2] The authors focus on ecological inequality measurement and the estimation of impact drivers in a cross-sectional setting for separate years which differs to our approach substantially and may not capture evolution over time.

add to the quantitative literature on the ecological consequences of globalization (Dreher et al., 2008; Potrafke, 2014).

Drawing on the IPAT identity (Ehrlich & Holdren, 1971; York, Rosa, & Dietz, 2003b) our results suggest that environmental impacts (I) are driven by population (P), affluence (A) and technology (T).[3] The EBA further reveals that besides the latter three a larger vector of controls is robustly related to ecological pressures. The relationship to globalization, however, is less clear than previously assumed; it is rather distinct depending on the aspect of globalization and perspective of the Ecological Footprint. The EF of consumption and production are not affected by overall globalization whereas we find a positive association with the EF of exports and imports. We find that there is no relationship between political and economic globalization and the EF, but social globalization is negatively related (awareness increasing) with the EF of production and positively (obliviousness) with the EF of exports and imports.

The remainder of this paper is organized as follows. Section 2 explains the concept and empirical operationalization of human ecological demands as well as of globalization and develops testable hypotheses. Section 3 describes the estimation strategy including the EBA, the control variables and the hypotheses tests. The results are presented in Section 4 which also discusses endogeneity concerns. Section 5 concludes.

2. Human demands on the environment and globalization

According to the Ecological Footprint Atlas (Ewing et al., 2010) we have lived in the state of ecological overshoot since the 1970s which means that human demands have exceeded the Earth's biocapacity (WWF, 2014).[4] Human demands alter ecosystems by creating ecological pressures such as land-use changes, resource extraction and depletion (e.g., deforestation and overfishing), emissions of waste and pollution and the modification and movement of organisms (Steffen et al., 2005; UNEP, 2012a). The resulting environmental impacts include, but are not limited to climate change, land degradation, loss of biodiversity and pollution. Consequences affect primarily the very poor and vulnerable populations in developing countries through famine, water shortages, and competition over resources, among others (Field et al., 2014).

This shows that human environmental demand and globalization are phenomena that include various dimensions making a one-sided assessment through single stressors (e.g., CO2 pollution) or considerations (e.g., trade) prone to omitted variable bias. The availability of holistic indicators in both cases thus has the advantage of addressing various dimensions

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[3] In reference to the literature to quantify specific drivers and test hypothesis we use the STIRPAT (Stochastic Impacts by Regression on Population, Affluence and Technology) formalized by York et al. (2003b).

[4] In 2007 the total global Ecological Footprint was 18 billion *gha* with an EF per capita of 2.7 *gha*, and biocapacity only 11.9 billion *gha* or 1.8 *gha* per capita (Ewing et al., 2010).

simultaneously without risking problems of multicollinearity in empirical work. In this respect we use Ecological Footprint data provided by the Global Footprint Network (2012b) and a multidimensional measure of globalization from Dreher (2006) and Dreher et al. (2008).

2.1 The Ecological Footprint of nations

Measurements of environmental footprints allow the quantification of human ecological demands (Hoekstra & Wiedmann, 2014).[5] The EF captures a whole set of human demands on the environment by "measuring how much area of biologically productive land and water[6] an individual, population or activity requires to produce all the resources it consumes and to absorb the waste (carbon dioxide) it generates, using prevailing technology and resource management practices" (Global Footprint Network, 2012a).

The EF is currently the most complete indicator to assess the relationship between globalization and ecological demands for several reasons: first, the aggregation is based on six bio-productive land-use types: i) cropland, ii) grassland and pasture (food and fiber), iii) fishing grounds (seafood), iv) forests land (timber and paper products) as well as v) area required for built infrastructure (e.g., roads and buildings) and vi) land for carbon sequestration. Second, the indicator is globally comparable. The EF is measured in global hectares (gha) which do not only refer to a physical area, but also take its ecological productivity into account.[7] Third, the EF is scientifically rigorous (based on input-output tables) and widely accepted across the social sciences, including ecological economics (Jorgenson & Clark, 2011). Further, it is commonly used and employed in policy reports, such as the Global Environment Outlook (UNEP, 2012a) and the yearly Living Planet Report (WWF, 2014). In the 2011 edition of the National Footprint Accounts (NFA) (Global Footprint Network, 2012b), which we employ, data are available for 240 countries and territories for the years 1961-2009 covering most of the time period which is coined as contemporary globalization (Rennen & Martens, 2003) . Third, the NFA takes the effects of trade flows into account, by reporting Ecological Footprints from different perspectives, composed of production, imports and exports in the following form:

$$EF_{consumption} = EF_{production} + EF_{imports} - EF_{exports}$$

This makes an assessment on different levels possible because it allows disentangling the influence of globalization on several aspects of human ecological demands on the environment. Since we find a simple positive correlation between the EF of consumption and overall

[5] Other approaches are, for example the water and carbon footprint (Hoekstra & Wiedmann, 2014).

[6] Definition of biologically productive land and water: the land and water (both marine and inland waters) area that supports significant photosynthetic activity and the accumulation of biomass used by humans. Non-productive areas as well as marginal areas with patchy vegetation are not included. Biomass that is not of use to humans is also not included, from the online GFN Glossary.

[7] For more detailed information on the exact calculation methodology we refer to Borucke et al. (2013).

globalization, it is not only important to analyze whether this holds controlling for confounding factors, but also for the different perspectives of the EF.

Besides its general relevance, the Ecological Footprint also has some caveats. According to Galli et al. (2012) the major limitation of the EF is that it is not geographically explicit, meaning that it does not assign exact localities of environmental pressures, but aggregates only at the country level disregarding sub national levels. This is of minor relevance to our study, since we are interested in the global perspective across countries. A second aspect is that pollutants and wastes such as phosphorus and nitrogen, nuclear waste and greenhouse gases (GHGs) other than carbon dioxide, which also have environmental impacts, are not included in the calculation. While aggregating various demands, the EF still only gives a partial picture of the problem and thus is not a catch-all sustainability indicator. Last, as pointed out by Borucke et al. (2013), National Footprint Accounts (NFAs) are a conservative measure of environmental pressures and are specifically constructed to underestimate EFs and overestimate biocapacity. These aspects need to be taken into account in the interpretation of our results, as the real effects can be considered to be much higher than what we find here. This is rather an advantage, because it makes sure that if we find effects they are truly influential in explaining the variation.

2.2 The KOF index of globalization

Measuring globalization in a consistent way across countries and time, we use the KOF Index of globalization which includes political, economic and social globalization (Dreher, 2006; Dreher et al., 2008). The 2013 version of the KOF covers 187 countries for the 1970-2009 period and allows disentangling the effects of different dimensions of globalization.[8] Other indices trying to capture globalization have the disadvantage of being only available for a small group of countries, i.e., OECD countries (Andersen & Herbertsson, 2005; Lockwood & Redoano, 2005) or are just available for a few points in time like the Maastricht Globalization Index (MGI), recently updated by Figge and Martens (2014).

Economic globalization includes variables on actual flows such as trade, FDI and capital flows. Restrictions include hidden import barriers, tariffs, taxes on international trade and capital controls. The second dimension of political globalization includes the number of embassies in the country, membership in international organizations and ratification of international treaties as well as participation in U.N. Security Council missions. Social globalization cumulates variables on personal contacts such as telephone traffic and international tourism, information flows including internet, newspapers and newspaper availability, and cultural proximity. The overall as well as the domain indices are scaled between 1 and 100, where 1 indicates a low level of globalization and 100 high levels of globalization. We use the overall index as well as the three sub dimensions to test our

[8] All variables included and their weights are detailed in Table A.1 in the appendix.

hypotheses, which are developed in the next section. All four indices are widely used in the literature (see Potrafke (2014), and citations therein).

2.3 Effects of globalization on human demands

A recent survey of more than 100 studies with the KOF by Potrafke (2014) reveals that the effects of globalization on the ecological environment has been mostly ignored in this field. We expect that globalization has an effect on ecological demands in addition to standard of living, technological intensity and population or simple acknowledgement of international trade, since globalization is a broad, multidimensional concept capturing global developments and interactions that go beyond these determinants. Other potential drivers are discussed in section 3.1 of this paper. First evidence about the relationship between globalization and the natural environment is provided by Dreher et al. (2008). The authors show that globalization is positively correlated with a decrease in air and water pollution which holds for the economic, social and political dimension. Lamla (2009) investigates robust determinants of pollution (carbon dioxide, sulfur dioxide and biochemical oxygen demand) and considers, among other factors, overall globalization as explanatory variable. However, he does not disentangle the different dimensions of globalization and focuses on long-term effects by considering cross-country differences.[9] In contrast we analyze explicitly the different dimensions of globalization and focus on the immediate impacts on ecological pressures for a country. We now take a closer look at how the three dimensions of globalization – the economic, political and social– potentially affect ecological demands and develop hypotheses.

2.3.1 Economic Globalization

We expect economic globalization to contribute to externalities in production, consumption and distribution process through enhancing trade relations and the lowering of trade barriers. This is what Borghesi and Vercelli (2003) refer to as uncontroversial correlation between globalization and environmental degradation. However, a priori the effect is not clear (Rennen & Martens, 2003) as globalization may also have alleviating effects on ecological demands. For instance, foreign direct investments (FDI) may lead to technology transfer and thereby diffuse clean production technologies allowing developing countries to leapfrog less efficient production processes (Gallagher, 2009; Tamazian, Chousa, & Vadlamannati, 2009; Tamazian & Rao, 2010). Global market integration, the argument goes, may then improve the allocative efficiency of domestic markets and promote private property and thereby contribute to internalization of ecological externalities (Dinda, 2004). Therefor our `markets for the global environment' hypothesis suggests that economic globalization decreases ecological demands.

[9] He finds differing correlations for different pollutants in the long-run: positive for carbon dioxide and negative for sulphur dioxide and biochemical oxygen demand (Lamla, 2009).

On the contrary, considering the `displacement and pollution haven hypothesis', economic globalization leads to growth of more pollution-intensive industries in countries with lower environmental regulations, which is the case in many developing countries (Copeland & Taylor, 2004). Generalized to all countries this translates into an 'intensification' hypothesis that expects economic globalization to intensify ecological demands in all countries and is based on four observations: first, there is currently no effective (global) framework for governing land-use and carbon emissions, which would allow for globally binding regulations. Second, more developed countries rather intensify agricultural production and their energy use which increases ecological stressors (UNEP, 2012a). Third, economic globalization may contribute to a 'race to the bottom' (Dinda, 2004), where countries that are more globalized economically through trade and investment are also more likely to avoid footprint mitigation in order to safeguard economic objectives. We expect the second line of argumentation more relevant given previous studies and ambiguous claims regarding the diffusion of cleaner technology.

2.3.2 Political globalization

Political integration ties states to each other through bilateral diplomatic contacts, international organizations and trans-national agreements. The evidence on whether closer political integration may reduce human demands on the environment is rather mixed (Lemos & Agrawal, 2006). Stiglitz (2007) points out that economic globalization has outpaced political globalization and as a result there is a lack of governance institutions to effectively address global issues such as climate change and inequality. Up until now no strictly enforceable global framework for greenhouse gas emissions is in place. Studies show that the Kyoto protocol was not able to effectively tackle climate change (e.g., Den Elzen and De Moor (2002) and it is still not clear whether the United Nations Framework Convention on Climate Change (UNFCCC) is capable of producing an effective successor. When it comes to global environmental issues other than climate change, measurable progress has only been made with respect to stratospheric ozone and lead in gasoline. Progress on other environmental issues such as deforestation, desertification or overfishing is mostly lagging behind (UNEP, 2012b). It, thus, seems that global governance still lags behind in managing adverse environmental effects of economic development.[10] Global governance exposes nations and people to institutions and structures suffering from lack of democracy, accountability and transparency. This may contribute to power abuses (Grant & Keohane, 2005) and potential adverse ecological impacts, because for instance more attention is put on investment goals than on environmentally sustainable consumption, production and trade. This suggests a `global environmental governance failure' hypothesis expecting a positive correlation between political globalization and the EF.

[10] Newell (2001) provides an overview of different regulation approaches of multinational companies focusing on environmental initiatives and shows that surveillance of such private global actors is difficult because heavy polluters seem difficult to capture.

On the other hand, Lemos and Agrawal (2006) conclude that political integration has beneficial effects on the capacity and effectiveness of governance institutions to mitigate human demands on the environment. Countries that are more politically integrated, the argument goes, benefit from access to global institutions, know-how and monitoring systems. Also, political cooperation often aims at building institutional capacity which advances institutions for environmental regulation and facilitates negotiations. Rather than a race to the bottom, there may also be a rising of the bottom by disseminating environmental governance to developing countries (Dinda, 2004). The 'global environmental governance' hypothesis suggests that political globalization decreases ecological pressures and human demands though theoretical arguments could explain a null effect if the opposing effects compensate for different institutions.

2.3.3 Social globalization

Social globalization exposes people and nations to global streams of information and knowledge (Rennen & Martens, 2003). Countries are also more socially globalized if the population is able to access and use these media sources and has more personal international contacts. In principle, we would expect more socially globalized societies to know more about (global) environmental problems through the availability of information based on newspapers and increased access to the internet, social media and telephone lines. As people have increasing access to education and information about negative side effects of consumption and production, environmental awareness increases together with demand for 'cleaner' products (Motoshita, Sakagami, Kudoh, Tahara, & Inaba, 2015). At the same time producers promote their 'clean' products increasing public understanding even more (Najam, Runnalls, & Halle, 2007). Thus social integration can give rise to more informal regulation, by empowering civil society, consumers, but also businesses and governments to cooperate in new governance structures and create general pressure for pro-environmental behavior, adaption and regulation (Dinda, 2004). The 'global environmental awareness' hypothesis suggests that social globalization decreases ecological pressures.

In contrast, global mobility of people, including migration, may physically and mentally distance individuals from the negative environmental (and social) impacts of the global economy (Dinda, 2004). Physical distancing refers to simply moving away from environmental problems. Mental or cognitive distancing are the result of socio-economic and cultural tele-connections, which inhibits the understanding of how social and ecological problems elsewhere are connected to one's own individual behavior (Steffen et al., 2005). As a result, more information about environmental problems does not by itself lead to greater environmental awareness and concern. Additionally, consuming ever more global media exposes people to advertisements and other media contents that disseminate materialistic and consumerist values (Najam et al., 2007; Rennen & Martens, 2003). Increased meat and dairy consumption, mobility and international tourism are all drivers of ecological pressures. Thus, one could also expect, a `socio-cultural distancing' hypothesis where social globalization increases ecological pressures. A priori we have no expectations which effect dominates.

3. Estimation strategy

Using the Extreme Bounds Analysis (EBA) a robust set of control variables is identified before we test the globalization hypotheses. Our analysis covers 146 countries worldwide for the years 1980-2009 in an unbalanced panel depending on the availability of data for the explanatory variables.

3.1 Extreme Bounds Analysis and basic drivers

Since the evidence on determinants of the Ecological Footprint so far is mixed, we follow the literature (e.g., Dreher, Gassebner, and Siemers (2012), Gassebner et al. (2011) and Yang, He, and Chen (2015)) and use a variant of the Extreme Bounds Analysis (EBA) based on Leamer (1983), Levine and Renelt (1992), Sala-i-Martin (1997) and Sturm and De Haan (2005) to identify a robust vector of controls. The EBA is a statistical tool, to test whether the variables suggested in previous studies are indeed robustly related to Ecological Footprints, independent of other explanatory variables included in the regression. We use the following general equation to conduct the EBA:

$$\boldsymbol{Y}_{it} = \beta_M \boldsymbol{M}_{it-1} + \beta_F \boldsymbol{F}_{it-1} + \beta_z \boldsymbol{Z}_{it-1} + \vartheta_t + \tau_i + v_{it} \tag{1}$$

where $i = 1, \dots, N$ and $t = 1, \dots, T$. $\boldsymbol{Y}$ is the dependent variable; $\boldsymbol{M}$ is a vector of commonly accepted explanatory variables; $\boldsymbol{F}$ is a vector including the variable of interest; and $\boldsymbol{Z}$ is a vector of up to three additional variables (following Levine and Renelt (1992)). All variables are lagged by one year. Time-fixed effects (ϑ_t) and country fixed-effects (τ_i) as well as a standard error term (v_{it}) are included.

The EBA is applied in two steps. First, the robustness of the base model ($\boldsymbol{M}$) is tested by including one variable of the $\boldsymbol{F}$ vector while the remaining variables of the $\boldsymbol{Z}$ vector are used in all possible combinations of up to three at a time. In a second step the $\boldsymbol{M}$ vector is held constant and we test whether additional variables should be among the explanatory variables when testing for the impact of globalization. In order to decide whether a variable in $\boldsymbol{F}$ is robust we consider the whole distribution of the estimates as suggested by (Sala-i-Martin, 1997) and use the threshold value of 0.95 of the unweighted cumulative density function CDF(0) suggested by Sturm and De Haan (2005).[11] A CDF (0) of 0.95 indicates that at least 95 percent of the

[11] The originally very strict criterion proposed by Leamer (1983) and Levine and Renelt (1992) of a test of a variable in $\underline{\boldsymbol{F}}$ to be robust considers the lower bound of β_F (that is the lowest value minus two standard deviations) and the upper bound (highest value plus two standard deviations) of this coefficient to both be on one side of zero. However,

distribution lies on one side of zero which is regarded as support for a variable to have a robust statistical effect. [12]

Arguably, the choice of the variables of the baseline model in the $\boldsymbol{M}$ vector as well as selection into the $\boldsymbol{Z}$ vector is arbitrary. However, we base our selection for $\boldsymbol{M}$ on the existing theory and empirical findings to identify core determinants (base model). According to the IPAT equation environmental impacts in a nation (I) are determined by the size and composition of the population (P), the level of affluence (A) and the state of technology (T) (Dietz, Rosa, & York, 2007; Rosa, York, & Dietz, 2004; York et al., 2003a, 2003b).[13] We use the share of economically active population, which has been shown to consistently relate to the EF of consumption (Dietz et al., 2007; Teixidó-Figueras & Duro, 2015; York et al., 2003a). Further, we use (ln) GDP per capita as a measure of affluence or the standard of living in a country, and (ln) GDP per capita squared to account for a potential non-linear relationship as suggested by the Environmental Kuznets Curve (EKC) relationship (Antweiler et al., 2001; Dinda, 2004; Gallagher, 2009).[14] Third, we include the ratio of energy use to GDP which is a measure for the energy intensity of production and therefore a good proxy for the state of the technology. While the IPAT identity strongly suggests explicit treatment of the technological dimension, many empirical studies and theoretical findings regarding the EKC so far primarily focus on income per capita, without explicitly including a proxy for technology use. The assumption is that the technological dimension operates through income and therefore no explicit treatment is necessary (Copeland and Taylor, 2004; Gallagher, 2009b; Gassebner et al., 2010b). However, disentangling impacts on the environment makes a formal treatment of technology necessary.[15] All variables are from the World Development Indicators database (World Bank, 2014).

Sala-i-Martin (1997)shows that this criterion is a very strong one and a researcher is bound to find a positive or negative coefficient if both directions are supported. He suggests considering a variable to be robust when the CDF is 0.9.

[12] For a detailed discussion on advantages and limitations of the EBA see Gassebner et al. (2011).

[13] The findings show an intensification of human demands as the income level increases in a U-shaped relationship (see e.g., Dietz, Rosa, and York (2012) and Jorgenson and Clark (2011)) and a positive population elasticity being close to one (Dietz et al., 2007; Rosa et al., 2004; York et al., 2003a). If more variables are tested the results are generally ambiguous (e.g., Jorgenson, Clark, and Kentor (2010); Jorgenson and Rice (2005); Jorgenson, Rice, and Crowe (2005)). A variety of approaches without addressing robustness concerns is used: Dietz et al. (2007), Rosa et al. (2004), York et al. (2003a), (Jorgenson, 2003, 2004, 2005) employ cross-sectional analysis, whereas Jorgenson and Clark (2011), Jorgenson et al. (2010), Jorgenson and Rice (2005) and Jorgenson et al. (2005) use panel data, but rely on averaged observations or a very short period of time. Moreover, these studies disregard multi-dimensional aspects of globalization and mainly consider partial aspects of it such as trade (Jorgenson & Clark, 2009).

[14] Environmental and ecological economists reduce the discussion on the relationship between income and single environmental indicators and hypothesize an inverse u-shaped Environmental Kuznets Curve (EKC) for various aspects of environmental quality and respective pollutants (Copeland & Taylor, 2004; Dinda, 2004; Gallagher, 2009).

[15] Previously, it has been argued that increasing income may induce three different effects: scale effects, composition effects and technique effects (Grossman & Krueger, 1995). We argue that only the scale effect can be considered as an income effect and that the technique and composition effect need to be accounted for separately in empirical investigations, as otherwise the findings for income may suffer from an omitted variable bias.

For the ***F*** vector we consider 29 additional variables. First, our three globalization measures, and further variables suggested by the literature on EF and pollution.[16] These variables can be categorized in five dimensions: demographic, economic, geographic, cultural and political. Demographic determinants other than economically active population are population growth and density (Gassebner et al., 2011; Lamla, 2009) and the share of the population living in urban areas (Dreher et al., 2008; Jorgenson & Clark, 2011). The results for these variables have not been conclusive. Additional economic factors that have been tested by Lamla (2009) and Gassebner et al. (2011) are GDP growth and manufacturing share of GDP. Jorgenson and Burns (2007) include the agriculture share of GDP to test for the effect of the agricultural sector. We further include 'socio-economic conditions' to control for general macro-economic conditions of the country. Data is provided by the International Country Risk Guide (PRS Group, 2012). As additional geographic variables, we include per capita land area and arable land as a share of total land since they have an influence on the capacity of the countries to compensate pollution and absorb waste (Dietz et al., 2007; Jorgenson & Clark, 2011).

Environmental awareness is a key determinant of human demands on the environment, because it influences consumption patterns in mobility and energy consumption (UNEP, 2012a). We test other energy intensity variables including fossil fuel energy consumption, electricity production from oil sources, and the share of alternative and nuclear energy provided by the World Bank (2014). To capture the effect of mobility, we employ road sector energy consumption in total and in per capita terms and CO2 as a global pollutant.

(Environmental) governance structures and processes have an impact on ecological human pressures through regulation, standards, management and political and legal institutions (Dinda, 2004; Gallagher, 2009). The capacity and effectiveness of governance institutions are proxied by corruption, law and order, bureaucratic quality, government stability, democratic accountability and regime type (PRS Group, 2012). Another political variable suggested by Lamla (2009) is the number of years the chief executive has been in office (T. Beck, Clarke, Groff, Keefer, & Walsh, 2001) following the notion that long-term rule reduces the willingness to control for environmental stressors.

Finally, Dreher et al. (2012) suggest that issues regarding the internal and external security of a population may play a crucial mediating role. Countries that face high levels of external or internal conflict may have weak institutions, low productivity and destroyed infrastructure additional to the hardship the population faces. This might reduce the respect for "eco-rights" and thus increase ecological pressure.[17] We therefore include variables for physical integrity rights, internal and external conflicts. Similarly, Jorgenson et al. (2010) emphasize the role of

[16] All variables, their definition and sources are listed in Table A.3 in the appendix.

[17] Dreher et al. (2012) look at the relationship between globalization and human rights; one could argue that high ecological footprints and increasing levels of pollution are a violation of eco-rights, which are comparable to human rights.

military actions on ecological pressures which is captured by 'military in politics' and military expenditure as a share of GDP provided in the WDI data (World Bank, 2014).

Taking all factors into account we might face multicollinearity problems with variables that potentially overlap. This is most likely when variables are related to each other as is the case for example by using land area and arable land as share of total land area. Therefore we carefully investigated the correlations between our explanatory variables and take it into account when analyzing the results of the EBA in Section 4.1.[18]

3.2 Empirical specification

We test our hypotheses by estimating equations of the following form:

$$Y_{i,t} = \beta_1 Y_{i,t-1} + \beta_2 X_{i,t-1} + \beta_3 Glob_{i,t-1} + \lambda_t + \mu_i + \varepsilon_{i,t} \qquad (2)$$

where $Y_{i,t}$ is the natural log of the annual EF per capita measure described above and $Y_{i,t-1}$ is the lag dependent variable which captures the persistence in the evolution of the EF. $X_{i,t-1}$ is a vector of robust factors influencing human environmental demands identified by the EBA, and $Glob_{i,t-1}$ is overall globalization or all of the three sub-indices. We expect the variables to affect the Ecological Footprints with a time lag of one year only, since the drivers affect the demand for a land-use type and the respective resources included in the calculation of the EF only with a short delay. The term λ_t describes the time fixed-effects and μ_i is the country fixed- effects.[19] By employing the within fixed-effects estimator with time fixed-effects we control for unobserved time invariant and time variant common shocks which capture cross-sectional dependence that is homogenous across countries. The idiosyncratic error term is $\varepsilon_{i,t}$. Consequently, our estimates exploit variation within countries around a common trend and our parameter vector of interest (β_3) can be interpreted as the short-run effect of globalization on the EF.

This specification raises some econometric issues. Since the lagged dependent variable is included, first, long term effects are affected by the coefficient of the lagged dependent variable as well. Second, this coefficient also comprises the unobserved country effects which could lead to downward bias the state dependence in the fixed-effects specification (Nickell, 1981). This Nickel bias is decreasing in *T*. Since our panel has an average length of 25 time years, it should be reasonably small.[20] Another potential bias may arise with auto- and spatial correlation in the error structure. Autocorrelation inflates the z-statistic and cause invalid inference in a fixed-effects model (Bertrand, Duflo, & Mullainathan, 2004). We apply Pesaran's (2004) method

[18] The full pair-wise correlation table is provided in the appendix, Table A.4.

[19] The Hausman test rejects using the random effects estimator at the one percent level of significance.

[20] Dropping the lagged dependent variable from the models leads to generally similar results on our other explanatory variables, which also suggests that our main conclusions are not intensely affected by the Nickell bias. Additionally, Judson and Owen (1999) and N. Beck and Katz (1995) show that in panels with a *T* larger than 20 the bias is very small.

testing the null hypotheses of cross-sectional independence in the error terms which can be rejected on conventional levels. Therefore, we deal with these issues by adjusting the standard errors for heteroscedasticity, autocorrelation and cross-sectional correlation specific to each country, according to Driscoll and Kraay (1998).[21] This assures that the model is not prone to certain contaminating factors. However, it leaves open the possibility that both our index of globalization and ecological demands are affected by an underlying country-specific dynamic factor that is unobserved. We discuss potential endogeneity biases in section 4.3 and show that our estimates are robust to the adoption of an instrumental variable approach.

4. Empirical findings

We report the findings in three steps: first, we analyze the relevance (direction and magnitude) of the baseline and additional variables by discussing the EBA results. Second, we turn to our hypotheses. All robust variables of the extreme bounds analysis are included when evaluating the relationship between globalization and the EF. Finally, we discuss endogeneity concerns.

4.1 EBA results

Table 1 reports the results of the extreme bounds analysis for the per capita Ecological Footprint of consumption.[22] As expected we find the lagged dependent variable to be a highly significant determinant of the EF in the following year. The same holds for the income level, energy intensity (technology) and the share of economically active population. All effects are positive and statistically significant at least at the 5 percent level indicating that the per capita EF of consumption is related to the standard of living, technology and population positively.

The average effect of income on human pressures is positive, increasing and almost always significant (100 percent for the level and 82 percent of the squared term). There is no indication in the data of an EKC relationship which suggests a decrease in ecological pressures as countries grow wealthier. Rather we even find that higher GDP per capita is non-linearly correlated and relates to a disproportional increase of human demands. The magnitude is economically relevant since an increase by 5 percent in GDP per capita correlates to an increase

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[21] We additionally estimate the regressions by using cluster robust standard errors in the fixed-effects setting, the feasible generalized least squares estimator with heteroscedasticity and autocorrelated standard errors and linear regression with panel-corrected standard errors as suggested by N. Beck and Katz (1995). The results do not change qualitatively and are available on request.

[22] We also performed the EBA, first, using the within fixed-effects estimator with cluster robust standard errors. This does not change the findings qualitatively. We only show the Driscoll and Kraay (1998) adjusted standard errors results. Second, we used multivariate normal multiple imputation to impute the control variables and get a constant sample before applying the EBA. The results are not shown, but show the same results for the base vector. For the larger vector of controls the results are not exactly the same. However, the average coefficients are very small even suggesting no factors, besides the IPAT variables, are of sizable importance. Results are available on request. Since we find only minor differences in the average number of observations (Table 1) we expect no sample selection bias.

in the EF of about 1.1 percent. Energy intensity also shows a positive and robust significant coefficient on average. An increase of energy intensity by 10 percent relates to rising ecological pressures by almost 1 percent. Finally, an increase in the economically active population increases the EF per capita consistently and is statistically significant at least at the 5 percent level. A 5 percent increase in the EF is driven by an increase in the share of the economically active population by 1 standard deviation (around 6 percent). On average the effects seem plausible and sizable.

Table 1: EBA results Ecological Footprint per capita (1981-2009, 146 countries)

Variables	Avg. β	Avg. ν	%Sign.	CDF(0)	lower bound	upper bound	Combi	Avg. Obs
Base model								
Y (t-1)	0.579	0.061	1.00	1.00	0.000	0.754	4089	2569
(ln) GDP pc	0.212	0.034	1.00	1.00	0.000	0.341	4089	2569
(ln) GDP pc square	0.011	0.005	0.82	0.98	-0.012	0.035	4089	2569
(ln) Energy/GDP	0.102	0.017	1.00	1.00	-0.017	0.198	4089	2569
Population (15-65 yrs)	0.008	0.001	1.00	1.00	0.000	0.013	4089	2569
Extended model								
Agriculture/GDP	-0.002	0.001	1.00	0.99	-0.004	0.000	3682	2408
Urban population	-0.002	0.001	0.87	0.97	-0.007	0.001	3682	2553
External conflict	0.003	0.001	0.85	0.97	-0.002	0.009	3682	2339
Bureaucratic quality	0.008	0.004	0.86	0.97	-0.006	0.020	3682	2339
Social globalization	-0.001	0.000	0.70	0.96	-0.003	0.001	3682	2542
Population growth	0.007	0.005	0.30	0.91	-0.012	0.025	3682	2550
(ln) Area pc	0.057	0.032	0.35	0.90	-0.095	0.442	3682	2553
Government stability	0.002	0.002	0.23	0.89	-0.004	0.007	3682	2339
Years in office	0.001	0.000	0.33	0.89	-0.001	0.002	3682	2545
Physical integrity rights	0.002	0.002	0.07	0.88	-0.004	0.009	3682	2469
GDP growth	0.001	0.000	0.32	0.88	-0.001	0.003	3682	2543
Corruption	0.004	0.004	0.07	0.84	-0.009	0.016	3682	2339
Road energy per capita	0.000	0.000	0.73	0.84	0.000	0.000	3682	2530
Road energy consump. Share	0.001	0.001	0.59	0.79	-0.003	0.004	3682	2530
Internal conflict	0.001	0.001	0.01	0.78	-0.005	0.006	3682	2339
Oil energy	0.000	0.000	0.18	0.76	-0.001	0.001	3682	2530
Alternative and nuclear energy	0.000	0.000	0.01	0.68	-0.003	0.002	3682	2530
Fuel energy consumption	0.000	0.000	0.10	0.64	-0.003	0.002	3682	2553
Economic globalization	0.000	0.000	0.17	0.64	-0.001	0.003	3682	2504
(ln) Arable land share	0.006	0.014	0.00	0.63	-0.057	0.073	3682	2529
(ln) Military exp./GDP	-0.003	0.009	0.00	0.63	-0.028	0.023	3682	2048
Socio economic conditions	0.000	0.002	0.00	0.62	-0.005	0.006	3682	2339
Regime type	0.002	0.004	0.05	0.60	-0.020	0.042	3682	2552
Manufacturing/GDP	0.000	0.001	0.06	0.60	-0.004	0.003	3682	2261
(ln) CO2 pc	-0.003	0.011	0.05	0.59	-0.056	0.060	3682	2549
(ln) Population density	0.017	0.038	0.09	0.57	-0.319	0.472	3682	2530
Political globalization	0.000	0.000	0.31	0.56	-0.001	0.002	3682	2542
Law and order	0.000	0.003	0.00	0.55	-0.009	0.011	3682	2339
Democratic account.	0.000	0.002	0.01	0.54	-0.007	0.008	3682	2339

Notes: Dependent variable: EF of consumption per capita. The variables in the extended model are ordered according to the size of the CDF. *Y(t-1)* lagged dependent variable. Avg. β = average coefficient; Avg. ν = average Driscoll and Kraay adjusted standard error; %Sign. = percentage share coefficient is significant; CDF(0) = unweighted cumulative density function (threshold 0.95), lower (upper) Bound = lowest (highest) value of coefficient minus (plus) two standard deviation; Combi = # of variable combinations; Avg. Obs. = average # of observations. All variables are lagged by 1 year.

Using this baseline specification we find that additional variables are robust statistical determinants of the EF. The variables that are robust according to the threshold of Sturm and De Haan (2005) are the share of agriculture, the share of the urban population, external conflict, bureaucratic quality of the government and social globalization.

Social globalization is negatively correlated which supports the 'global environmental awareness' hypothesis. An increase in social globalization by 10 points on average, which is equivalent to the difference of the index in Argentina between 1991 and 1997 for example, is correlated to a decrease of 1 percent by the EF. The finding suggests that internationally on average social connectedness increases the awareness of populations towards sustainable environmental use and may have the potential to decrease human demands.

Turning to the other factors, the EF is also systematically and negatively related to the share of agriculture in total GDP. A decrease in the share of agriculture by one standard deviation (12.8 percent), which implies an equal increase in the share of the industrial and/or services sector, is associated with an average increase of 2.6 percent of the per capita EF. The share of urban population turns statistically significant in 87 percent of the regressions. It turns out to be negatively related to the EF where an increase in the share by 10 percent is related to a decrease of human pressures by 2 percent. This is rather counter intuitive since the general expectation is that urbanization increases ecological pressures (see e.g. Rees and Wackernagel (1996) or UNEP (2012a)). Although the results suggest that on average this trend goes hand in hand with an improvement of ecological pressures, the average coefficient is very small.

We also find that external conflict is correlated to lower levels of the EF. The coefficient is positive indicating that a decrease of two points (one standard deviation) on the twelve point scale, which is equivalent to an increase of external conflict risk, is correlated with a reduction of the EF by 0.6 percent. This at first sight again seems to be counter intuitive. We would expect countries that are affected by external conflict and threats of foreign action care less about eco-rights. However, on average the opposite seems to be the case. The final robust indicator is the bureaucratic quality index which on average is associated with a higher EF. In low risk countries, where the bureaucracy is strong and revisions of policies are less likely, higher human demands on the environment are observed. This is in contrast to expectations where hypothetically a better bureaucratic quality should enhance the capacity and effectiveness of governance institutions to mitigate human demands. Presumably, investment choices are prioritized over ecological sustainability. One might also think that a strong bureaucracy slows down environmentally sustainable adjustments of the economy, since more feasibility concerns have to be overcome. Keeping in mind that we look at short-term changes we might not be able to capture positive effects since structural change is more a long term process.

4.2 Main results

Turning to the hypothesis tests, the analysis of the relation between globalization and human environmental demands reveals some interesting findings. We report different specifications of Eq. (2). We always include the full vector of controls identified as robust in the EBA (less social globalization when overall globalization is tested). In order to make sure that our results are not driven by sample selection we also use the imputed sample.[23] Table 2 reports the main results. We find that overall globalization is negatively related to the EF of consumption. The size of the effect indicates that an increase by 10 units (out of 100) on the globalization scale (equivalent to the difference between the Switzerland and the US) relates to a decrease in the per capita EF of consumption of 1.2 percent. This can be considered a sizeable effect (given the observed variation in globalization). Although a very positive sign, we do not consider this result to be robust, because already when the constant sample is used the sign of the coefficient changes and the coefficient is not statistically significant anymore.

Turning to the different dimensions of globalization separately, we find only social globalization to be significantly and negative related to the EF of consumption. As noted before, the correlation indicates that social globalization may help in reducing human pressures on the environment. This effect vanishes when using the constant imputed sample. The coefficient of political globalization is negative but turns positive and statistically significant at the 10 percent level in the imputed sample indicating that politically more integrated countries have a higher EF per capita. Economic globalization never turns statistically significant in terms of EF of consumption.

[23] The multiple imputations on the control variables are performed using multivariate normal regressions with 20 imputations where the standard errors are adjusted according to Rubin's (1987) combination rule.

Table 2: EF per capita and globalization

Variables	EF consumption				EF production			
Globalization	-0.0012**		0.0002		-0.0003		-0.0000	
	(0.001)		(0.001)		(0.000)		(0.001)	
Political		-0.0001		0.0005*		-0.0002		-0.0000
		(0.000)		(0.000)		(0.000)		(0.000)
Social		-0.0014***		-0.0005		-0.0011***		-0.0002
		(0.000)		(0.001)		(0.000)		(0.001)
Economic		0.0001		-0.0000		0.0009**		0.0001
		(0.000)		(0.000)		(0.000)		(0.000)
# of Observations	2272	2258	4118	4118	2272	2258	4118	4118
# of Countries	113	111	146	146	113	111	146	146
R-squared (within)	0.574	0.575	imputed		0.707	0.711	imputed	

	EF imports				EF exports			
Globalization	0.0039***		0.0055***		0.0034***		0.0060***	
	(0.001)		(0.001)		(0.001)		(0.002)	
Political		0.0003		0.0004		0.0002		-0.0008
		(0.001)		(0.000)		(0.001)		(0.001)
Social		0.0022**		0.0034***		0.0026**		0.0056***
		(0.001)		(0.001)		(0.001)		(0.002)
Economic		0.0017**		0.0013***		0.0009		0.0012
		(0.001)		(0.000)		(0.001)		(0.001)
# of Observations	2272	2258	4118	4118	2272	2258	4118	4118
# of Countries	113	111	146	146	113	111	146	146
R-squared (within)	0.707	0.711	imputed		0.650	0.651	imputed	

Notes: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Driscoll and Kraay adjusted standard errors in parentheses. All regressions include the lagged dependent variable, country and period fixed-effects and the control variables: (ln) GDP pc and its square, (ln) energy/GDP, population (15-65 years), agricultural share in GDP, urban population, external conflict and bureaucratic quality measures. All explanatory variables are lagged by 1 year..

Since the EF is constructed from different perspectives we investigate whether globalization is differently related to the other variants of the Ecological Footprint. Thus we analyze the EF of production, imports and exports separately (Table 2). We find that multidimensional globalization is not related to the EF of production, but that it is significantly and positively related to the EF of imports and exports irrespective of whether we use the imputed sample or not. This suggests that the multidimensional process of globalization is systematically associated with the ecological pressures of trade. Countries that are more globalized exhibit higher EF of exports and imports. The size of the effects for the EF of imports and exports translates into an increase of around 3.9 and 3.4 percent when globalization increases by 10 units, respectively. The effects are even larger using the imputed sample. Thus, ceteris paribus, countries which are more globalized have higher ecological footprints of imports and exports.

Turning to the perspectives of the EF, we do not find any systematic relationship between political globalization and one of the subcomponents of the EF in any of the specifications. Interestingly we find that social globalization is differently related to different perspectives of the EF. For instance, for human environmental demands of production the relation is negative. The effect is statistically significant at the 1 percent level and indicates that increasing social globalization by 1 standard deviation (around 20 points) is related to a decrease in the EF of production by around 2.2 percent. This again provides evidence for the 'global environmental awareness' hypothesis where increased international connectedness seems to lead to a higher vigilance in national production. Again the systematic effect vanishes if we use the constant sample, but the sign is still negative. In contrast, in the case of EF of imports, we find a positive and significant correlation to social globalization. The magnitude of the effect translates into an increase of imported pressures by 4.5 percent if social globalization increases by one standard deviation in the not imputed sample. One possible explanation is that societies that are more open to other cultures have a higher demand for international products which translate into ecological pressures. The effect is independent of the sample size. The relation to ecological pressures of exports shows similar results. The coefficient is positive, and significant regardless of the sample. Regarding the last component of globalization, we find economic globalization to positively and significantly relate to the EF of production and imports. The coefficient is significant at the 5 percent level for both EF components, but only independent of the sample for the EF of imports. Presumably, more economically open countries exhibit higher environmental pressures of the traded products.[24]

Overall, the main findings indicate that globalization has no unambiguous effect on Ecological Footprints. We find no consistent relation to the EF of consumption. In terms of our hypotheses, we find no support for the `global environmental governance' hypothesis. If at all the effect seems rather devastating positively relating to ecological pressures. Especially, in terms of the EF of trade we robustly find that more globalized countries exhibit higher ecological pressures of imports and exports which both seems to be due to economic and social globalization.[25] For social globalization we find mixed evidence. On the one hand, the coefficient is negative (but not consistently significant) for the EF of consumption and production, lending support to the 'global environmental awareness' hypothesis. On the other hand, we find positive and consistently statistically significant coefficients for ecological pressures of imports and exports confirming our hypothesis of 'socio-cultural distancing'. For economic globalization we find support of our 'intensification' hypothesis from production and imports inducing ecological demand. These findings suggest that socially globalized societies increase their environmental

[24] We also ran regressions on the constant sample for all different specifications using only the base variables and also controlling for the larger vector of robust controls. The findings are qualitatively similar to the ones in Table.2. The main difference is that the systematic relationship of social and economic globalization to the per capita EF of production vanishes. The results for the ecological pressures of imports and exports are robust to different controls and sample size. The results are available from the authors upon request.

[25] If we analyze whether there is a different relationship in developing and industrialized countries, we do find some indication that more developed countries drive our results.

awareness towards local consumption and production, but are rather ignorant when it comes to imported or exported goods.

In order to analyze whether GDP per capita is one channel through which globalization relates to the EF, we perform the analysis excluding both variables (GDP per capita and its square). The findings are robust to this application (results not shown). We do find evidence that the correlation of globalization and human pressures of consumption and production are driven by the wealth level. The coefficients are larger in size and we find more to be statistically significant. However, the estimates suffer from an upward bias due to omitted variables.[26] Given that we control for the main channels we are more restrictive, reduce omitted variable bias and are able to identify the pure effect of globalization that goes beyond income.

4.3 Endogeneity concerns

An important concern in the relationship between human environmental demands and globalization is endogeneity bias if either, the ecological demands are rather inducing globalization than the other way around, or if, an underlying dynamic factor has an impact on both phenomena. We now turn to address these issues step by step.

An important issue regarding the relationship between the EFs and globalization is the potential reverse causality in Eq. (2). It could be that an increase in the EFs causes global integration rather than being its outcome. Arguably, greater local human demand on the environment might also lead to higher levels of globalization. For instance, greater human environmental demands of a country may increase the country's willingness to participate in international agreements or organizations to help reduce or meet these demands. We do three things to ensure that our estimates are not biased: first, we (already) lagged all explanatory variables. Second, we follow Dreher et al. (2012) and perform Granger-causality tests. This test states that, according to Granger (1969) variable x causes variable y, if past values of x help explain y, once controlled for past influence of y in the following way:

$$y_{it} = \sum_{j=1}^{m} \alpha_j y_{it-j} + \sum_{j=1}^{m} \beta_j x_{it-j} + \delta_i + \xi_t + \omega_{it} \tag{3}$$

where $i = 1, \dots, N$ and $t = 1, \dots, T$. We estimate a fixed-effects panel estimator where α_j and β_j are the parameters, m is the maximum lag length, δ_i is the country fixed-effect, ξ_t is the time fixed-effect and ω_{it} is the idiosyncratic error term clustered on the country level. The stationary assumption of the series is tested by employing a Maddala and Wu (1999) test for unbalanced panel data. The null hypothesis of all series being non-stationary can be rejected at the one percent level. We report the results of the Granger-causality test in Table 3 where the F-statistic

[26] The results are available upon request from the authors.

on β_j together with the respective p-value is displayed testing the null hypothesis that x Granger-causes y.

Table 3: Granger causality (1981-2009, 146 countries)

	y = EF, x = Glob		y = Glob, x=EF	
		EF consumption		
Overall	2.91	(0.057)	1.69	(0.188)
Political	2.84	(0.062)	2.03	(0.136)
Social	2.02	(0.136)	0.67	(0.514)
Economic	2.80	(0.065)	0.19	(0.831)
		EF production		
Overall	6.37	(0.002)	2.81	(0.063)
Political	3.45	(0.035)	3.13	(0.047)
Social	1.40	(0.249)	1.18	(0.312)
Economic	6.29	(0.003)	1.15	(0.319)
		EF imports		
Overall	7.49	(0.001)	2.86	(0.061)
Political	3.89	(0.023)	1.45	(0.237)
Social	5.22	(0.006)	3.44	(0.035)
Economic	9.50	(0.000)	1.20	(0.303)
		EF exports		
Overall	8.62	(0.000)	1.30	(0.275)
Political	1.63	(0.199)	1.00	(0.369)
Social	5.43	(0.005)	3.73	(0.026)
Economic	3.71	(0.027)	0.70	(0.497)
	F-statistic	p-value	F-statistic	p-value

Notes: The table reports *F*-statistics (joint significance) and the respective p-values in parentheses using two lags.

The first pair of results shows the values testing the null hypothesis that globalization does not Granger-cause EFs. We find evidence that globalization granger causes the Ecological Footprints, except in the case of social globalization on the EF of consumption and production and in the case of political globalization on the EF of exports. The second pair of results (column 2) tests for the null hypothesis that the Ecological Footprint does not Granger-cause Globalization. We cannot reject the null hypothesis for EF of consumption and confirm that globalization Granger-causes the EF. The exercise shows that we can interpret the effect of economic globalization as Granger-causing the EF and its components as we never fail to reject the null but we have to be careful in the consideration of political and social globalization where Granger causality seems to be unclear.

Third, we do a crude test where we exchange the globalization indices and the EFs in Eq. (2) as dependent and independent variables. We report the results in Table 4. The lagged EF as well as all components never turn statistically significant at conventional levels when regressed on the globalization indicators. Overall, we provide evidence that causality runs from globalization to human ecological demands. For social globalization a careful consideration of the underlying mechanism needs to be taken into account.

Table 4: Reverse relation

	Overall globalization				Political globalization				Social globalization				Economic globalization			
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(ln) EF of consumption	0.043				0.131				-0.133				0.198			
	(0.230)				(0.555)				(0.330)				(0.300)			
(ln) EF of production		-0.231				-0.668				-0.111				-0.292		
		(0.344)				(0.546)				(0.368)				(0.590)		
(ln) EF of imports			0.072				-0.041				0.027				0.187	
			(0.084)				(0.251)				(0.071)				(0.221)	
(ln) EF of exports				-0.081				-0.290				0.075				-0.124
				(0.080)				(0.180)				(0.100)				(0.120)
# of observations	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3071	3071	3071	3071
# of Countries	146	146	146	146	146	146	146	146	146	146	146	146	129	129	129	129
R-squared (within)	0.963	0.963	0.963	0.963	0.869	0.869	0.869	0.869	0.948	0.948	0.948	0.948	0.928	0.928	0.928	0.928

Notes: Dependent variables are the globalization indicators; Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All regressions include the lagged dependent variable and the base controls: (ln) GDP per capita, energy use and population share (15-65 years), as well as time and country fixed-effects. Driscoll and Kraay adjusted standard errors are in parenthesis.

The second potential source of endogeneity could be an omitted variable bias where an omitted factor influences ecological pressures and globalization simultaneously. To tackle this issue Wooldridge (2010) suggests the use of an instrumental variable approach. We apply difference and system Generalized Method of Moments (GMM) estimators with internal instruments to estimate Eq. (2) and find qualitatively no difference in the results. We do not focus our main findings on these results, because of several reasons: The additional assumption made by system GMM is that the initial conditions ($y_{i,1}$) represent a stationary process of the underlying data generating process. This requires that there is no correlation between variations from the long term mean and the stationary country-specific long term mean of the dependent EF variable (Blundell & Bond, 1998). In the case of the Ecological Footprint this seems to be a very strong assumption, since there is no reason to believe that the speed of change in human demands is unrelated to its current level. Furthermore, Roodman (2009) shows that both differenced and system GMM estimates are often unstable and strongly depend on the instrument matrix used. Bun and Windmeijer (2010) also demonstrate that the level equation in system GMM similarly to the difference equation in difference GMM suffers from a weak instruments problem biasing the results. A possible solution to reduce the bias would be convincing exogenous variation in globalization that does not affect ecological demand which we think is very difficult, if not impossible to find.[27]

5. Conclusions

Summing up, this paper provides a systematic empirical analysis of the drivers of ecological demands and examines if and how globalization as a multidimensional process is related to these human induced environmental pressures. In contrast to the existing literature, we apply comprehensive measures of both phenomena using the Ecological Footprint and a multidimensional globalization index. We identify basic determinants and extract a robust set of relevant factors before we test our hypotheses. We also employ a panel data setting with fixed country and year effects accounting for cross-section interdependence in the standard errors. Additionally, we address endogeneity issues in various ways. First, we exploit the time structure of the data set and show that globalization Granger-causes ecological pressures rather than the other way round for most dimensions. Secondly, we use the dynamic panel data estimator of two-step system GMM, which points in the same direction.

Our main finding is that globalization is related to ecological pressures in a diverse manner. We try to capture these diversities by looking not only at the EF of consumption, but also the EF of production, imports and exports separately and disaggregate globalization into economic, social and political dimensions. Social globalization is identified as robust

[27] We are not aware of any approach which develops a convincing instrument for globalization and does not affect ecological pressure other than through globalization. Using average neighbouring (political allies, geographical distance countries) values of sub-components of the KOF index (see e.g., Vadlamannati (2015)) has the same potential endogeneity as the overall index.

factor relating to ecological pressures of consumption and production negatively and to imports and exports positively. On the one hand, this support the hypothesis that increased social connectedness may help to reduce environmental stressors and foster sustainable development especially in national consumption and production. Regarding ecological pressures induced by imports and exports, this effect disappears and we find social globalization to even enhance ecological demands. The more socially globalized a country is the less important seem to be environmental stressors embedded in imports and exports. Societies in more socially globalized (developing) countries seem to care less about sustainability concerns in traded goods, presumably because they are increasingly confronted by materialistic and consumerist values. Since we cannot rule out reverse causality completely, social globalization may also be caused by ecological pressures.

For economic and political globalization we find some support of an enhancing influence, but not robust to different tests. Interestingly, political globalization seems to be of less importance in shaping human demands on the environment. International efforts do not influence these pressures in the short run. Since we only investigate the short term relationship, there might still be a long-term influence which we do not capture here. Thus, in contrast to the simplifying statement of Borghesi and Vercelli (2003) we do find diverse relationships of globalization and environmental human demands. The analysis reveals that a careful consideration of the perspective of examination is important when claiming that globalization increases environmental human demands.

The empirical observation that according to the EF data, humanity has lived in ecological overshoot since the 70s and in 2010 has demanded resources and services which would require 1.5 Earths (WWF, 2014) begs the question what would be effective leverage points to reduce our common footprint to 1 Earth. Our findings for the 1981 - 2009 period suggest that policies foremost should focus on a reduction of GDP inequalities since globalization as such includes various aspects difficult to capture singularly. A focus on social interconnectedness seems promising in increasing awareness within societies with the potential to reduce ecological demand.

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Appendix

Table A1: KOF Index of Globalization (2014)

	Indices and Variables	Weights
A.	**Economic Globalization**	**[36%]**
	i) Actual Flows	(50%)
	Trade (percent of GDP)	(21%)
	Foreign Direct Investment, stocks (percent of GDP)	(27%)
	Portfolio Investment (percent of GDP)	(24%)
	Income Payments to Foreign Nationals (percent of GDP)	(27%)
	ii) Restrictions	(50%)
	Hidden Import Barriers	(24%)
	Mean Tariff Rate	(28%)
	Taxes on International Trade (percent of current revenue)	(26%)
	Capital Account Restrictions	(22%)
B.	**Social Globalization**	**[38%]**
	i) Data on Personal Contact	(33%)
	Telephone Traffic	(25%)
	Transfers (percent of GDP)	(4%)
	International Tourism	(26%)
	Foreign Population (percent of total population)	(21%)
	International letters (per capita)	(24%)
	ii) Data on Information Flows	(35%)
	Internet Users (per 1000 people)	(36%)
	Television (per 1000 people)	(37%)
	Trade in Newspapers (percent of GDP)	(27%)
	iii) Data on Cultural Proximity	(32%)
	Number of McDonald's Restaurants (per capita)	(45%)
	Number of IKEA (per capita)	(45%)
	Trade in books (percent of GDP)	(10%)
C.	**Political Globalization**	**[26%]**
	Embassies in Country	(25%)
	Membership in International Organizations	(28%)
	Participation in U.N. Security Council Missions	(22%)
	International Treaties	(25%)

Source: Dreher (2006), updated version 2014.

Table A2: Variables and sources

Variable	Description	Source	Mean	Std. Dev.	Min	Max
(ln) EF pc of consumption	Natural logarithm of the Ecological Footprint (EF) per capita of final consumption	Global Footprint Network (2014)	0.88	0.69	-0.72	2.83
Overall globalization	Globalization multidimensional index: 1 (not globalized), 100 (completely globalized)	Dreher (2006), Dreher et al. (2008); version 2014	53.47	17.89	15.04	92.50
Economic Globalization	Economic globalization including restrictions and flows (1 low; 100 high)	Dreher (2006), Dreher et al. (2008); version 2014	54.02	19.14	9.94	99.16
Social Globalization	Social globalization including cultural proximity, personal contacts and information flows (1 low; 100 high)	Dreher (2006), Dreher et al. (2008); version 2014	44.93	22.62	4.64	93.68
Political Globalization	Political globalization (1 low; 100 high)	Dreher (2006), Dreher et al. (2008); version 2014	63.07	20.99	6.47	98.26
(ln) GDP per capita	Natural logarithm of GDP (constant 2005 US$) per capita	World Bank (2014)	8.15	1.57	4.72	11.38
(ln) GDP per capita squ.	Squared natural logarithm of GDP (constant 2005 US$) per capita	World Bank (2014)	2.53	2.58	0.00	12.02
Energy/GDP	Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP)	World Bank (2014)	5.29	0.60	1.94	7.36
Population (15 -65 years)	Share of population between 15 and 65 of the total population	World Bank (2014)	60.98	6.63	45.29	84.68
(ln) Arable land share	Natural logarithm of arable land (% of land area)	World Bank (2014)	-1.77	1.23	-9.00	1.12
Agriculture/GDP	Agriculture, value added (percent of total GDP)	World Bank (2014)	14.51	12.78	0.04	68.88
Oil energy	Electricity production from oil sources (percent of total)	World Bank (2014)	21.44	28.32	0.00	100.00
Altern. and nuclear energy	Alternative and nuclear energy (percent of total energy use)	World Bank (2014)	8.64	13.30	0.00	119.48
(ln) Area pc	Natural logarithm of total area available	Global Footprint Network (2014)	7.55	1.25	3.17	11.19
Fuel energy consumption	Fossil fuel energy consumption (percent of total)	World Bank (2014)	65.77	31.10	0.00	103.55
Road energy	Road sector energy consumption (kt of oil equivalent)	World Bank (2014)	15.04	8.14	0.56	56.03
Road energy per capita	Road sector energy consumption per capita (kg of oil equivalent)	World Bank (2014)	341.05	445.18	1.85	4880.06
(ln) CO2 per capita	Natural logarithm of CO_2 emissions (metric tons per capita)	World Bank (2014)	0.83	1.52	-5.59	4.15
GDP growth	GDP growth (annual, percent)	World Bank (2014)	3.59	5.65	-42.45	88.96
(ln) Military exp./GDP	Natural logarithm of military expenditure as share of GDP	World Bank (2014)	0.69	0.71	-3.36	3.68
Manufacturing/GDP	Manufacturing industry value added (percent of GDP)	World Bank (2014)	16.49	7.19	0.00	43.54
(ln) Population density	Natural logarithm of population density (people per square kilometer of land area)	World Bank (2014)	4.05	1.37	0.21	8.84
Urban population	Urban population (percent of total population)	World Bank (2014)	56.78	22.03	6.09	100.00
Population growth	Growth rate of the general population	World Bank (2014)	1.62	1.51	-5.92	17.48
Years in office	Chief executive years in office.	Beck et al. (2001)	7.10	7.72	1.00	46.00
Regime type	Six-fold regime classification: 0. Parliamentary democracy; 1. Mixed (semi-presidential) democracy; 2. Presidential democracy; 3. Civilian dictatorship; 4. Military dictatorship; 5. Royal dictatorship.	Cheibub et al. (2010)	2.11	1.58	0.00	5.00
Physical integrity rights	The composite index of physical integrity rights is the additive of torture, extrajudicial killings, political imprisonments, and disappearance, ranging from 0-8	Cingranelli and Richards (2011)	4.92	2.30	0.00	8.00
Bureaucracy quality	Bureaucracy quality: 4(very low risk), 0 (very high risk)	ICRG (2012)	2.29	1.17	0.00	4.00
Corruption	Corruption within the political system: 6(very low risk), 0 (very high risk)	ICRG (2012)	3.17	1.37	0.00	6.00
Democratic accountab.	Democratic accountability: 6(very low risk), 0 (very high risk)	ICRG (2012)	3.94	1.61	0.00	6.00
External conflict	External conflict: 12(very low risk), 4(very high risk); 3 components	ICRG (2012)	9.88	2.05	0.00	12.00
Internal conflict	Internal conflict: 12(very low risk), 4(very high risk); 3 components	ICRG (2012)	9.04	2.52	0.00	12.00
Government stability	Government Stability: 12(very low risk), 4(very high risk); 3 components	ICRG (2012)	7.86	2.13	1.00	12.00
Socio econ. conditions	Socioeconomic conditions: 12(very low risk), 4(very high risk); 3 components	ICRG (2012)	5.90	2.23	0.00	11.00
Law and order	Law and order: 6(very low risk), 0 (very high risk)	ICRG (2012)	3.85	1.48	0.00	6.00
Military in politics	Military in Politics: 6(very low risk), 0 (very high risk)	ICRG (2012)	3.92	1.77	0.00	6.00

Table A3:

Countries under Study

Albania	Cyprus	Korea, Rep.	Sao Tome and Principe
Algeria	Czech Republic	Kuwait	Saudi Arabia
Angola	Denmark	Kyrgyz Republic	Senegal
Antigua and Barbuda	Dominican Republic	Latvia	Singapore
Argentina	Ecuador	Lebanon	Slovak Republic
Armenia	Egypt, Arab Rep.	Lesotho	Slovenia
Australia	El Salvador	Libya	South Africa
Austria	Equatorial Guinea	Lithuania	Spain
Azerbaijan	Eritrea	Luxembourg	Sri Lanka
Bahamas, The	Estonia	Macedonia, FYR	St. Lucia
Bahrain	Ethiopia	Malaysia	St. Vincent and the Grenadines
Bangladesh	Fiji	Maldives	Sudan
Barbados	Finland	Malta	Sweden
Belarus	France	Mauritius	Switzerland
Belgium	Gambia, The	Mexico	Syrian Arab Republic
Belize	Germany	Moldova	Tajikistan
Benin	Ghana	Mongolia	Tanzania
Bhutan	Greece	Morocco	Thailand
Bolivia	Grenada	Mozambique	Togo
Bosnia and Herzegovina	Guatemala	Namibia	Tonga
Botswana	Guinea-Bissau	Nepal	Trinidad and Tobago
Brazil	Guyana	Netherlands	Tunisia
Brunei Darussalam	Haiti	New Zealand	Turkey
Bulgaria	Honduras	Nicaragua	Turkmenistan
Cabo Verde	Hungary	Nigeria	Ukraine
Cambodia	India	Norway	United Arab Emirates
Cameroon	Indonesia	Pakistan	United Kingdom
Canada	Iran, Islamic Rep.	Panama	United States
Chile	Iraq	Paraguay	Uruguay
China	Ireland	Peru	Uzbekistan
Colombia	Israel	Philippines	Venezuela, RB
Comoros	Italy	Poland	Vietnam
Congo, Dem. Rep.	Jamaica	Portugal	Yemen, Rep.
Congo, Rep.	Japan	Qatar	Zambia
Costa Rica	Jordan	Romania	
Cote d'Ivoire	Kazakhstan	Russian Federation	
Croatia	Kenya	Samoa	

Table A4: Correlation matrix

	(ln) EF pc	Economic glob.	Social glob.	Political glob.	(ln) GDP pc	(ln) GDP pc sq.	(ln) Energy use	Population (15-64)	(ln) Pop. density	Urban population	Pop. growth	(ln) CO2 pc	(ln) Area	(ln) Arable land	Agriculture/GDP	GDP growth	Socioeco. cond.	Bureauc. quality	Corruption	Democratic acc.	External conflict	Internal conflict	Gov. Stability	Law and order	(ln) Military exp.	Manuf. share	Regime type	Years in Office	Physical integrity	Oil energy use	Alt./nuc. energy use	Fossil fuel use	Road energy pc
(ln) EF pc	1.00																																
Economic glob.	0.66	1.00																															
Social glob.	0.77	0.80	1.00																														
Political glob.	0.28	0.34	0.45	1.00																													
(ln) GDP pc	0.85	0.71	0.85	0.41	1.00																												
(ln) GDP pc sq.	0.30	0.29	0.35	0.26	0.31	1.00																											
(ln) Energy use	-0.22	-0.28	-0.31	-0.23	-0.44	0.13	1.00																										
Population (15-64)	0.69	0.61	0.74	0.42	0.72	0.21	-0.17	1.00																									
(ln) Pop. density	-0.01	0.08	0.19	0.01	0.11	0.09	-0.12	0.26	1.00																								
Urban population	0.67	0.60	0.67	0.46	0.75	0.16	-0.31	0.60	-0.02	1.00																							
Pop. growth	-0.23	-0.22	-0.33	-0.24	-0.26	0.08	0.05	-0.43	-0.17	-0.14	1.00																						
(ln) CO2 pc	0.80	0.65	0.73	0.35	0.86	0.14	-0.17	0.75	0.04	0.74	-0.23	1.00																					
(ln) Area	0.13	0.03	-0.09	-0.12	0.00	-0.08	0.07	-0.17	-0.82	0.02	0.11	0.01	1.00																				
(ln) Arable land	-0.08	-0.23	-0.18	0.24	-0.18	-0.11	0.17	-0.15	-0.57	-0.14	-0.22	-0.12	0.44	1.00																			
Agriculture/GDP	-0.65	-0.66	-0.71	-0.36	-0.82	0.01	0.48	-0.61	-0.08	-0.70	0.27	-0.78	0.01	0.23	1.00																		
GDP growth	-0.02	0.07	-0.01	0.00	-0.01	-0.05	-0.09	0.04	0.03	-0.04	0.09	-0.03	-0.04	-0.07	-0.02	1.00																	
Socioeco. cond.	0.62	0.53	0.63	0.24	0.69	0.44	-0.31	0.53	0.15	0.45	-0.09	0.60	-0.02	-0.22	-0.53	0.06	1.00																
Bureauc. quality	0.63	0.59	0.70	0.45	0.75	0.45	-0.28	0.56	0.14	0.48	-0.27	0.62	-0.04	-0.11	-0.59	-0.05	0.67	1.00															
Corruption	0.52	0.43	0.51	0.30	0.59	0.40	-0.21	0.34	0.00	0.40	-0.25	0.45	0.06	0.05	-0.42	-0.13	0.48	0.68	1.00														
Democratic acc.	0.44	0.49	0.55	0.54	0.52	0.26	-0.32	0.42	0.10	0.34	-0.42	0.36	-0.01	0.16	-0.44	-0.06	0.36	0.62	0.54	1.00													
External conflict	0.33	0.39	0.38	0.36	0.36	0.12	-0.14	0.39	0.04	0.22	-0.29	0.29	0.07	-0.01	-0.36	0.00	0.29	0.38	0.32	0.40	1.00												
Internal conflict	0.53	0.52	0.57	0.34	0.53	0.24	-0.13	0.53	0.03	0.39	-0.30	0.51	0.07	-0.02	-0.47	0.05	0.49	0.53	0.45	0.45	0.64	1.00											
Gov. Stability	0.22	0.35	0.35	0.18	0.24	0.12	-0.07	0.32	0.04	0.21	-0.08	0.26	-0.03	-0.12	-0.27	0.18	0.23	0.24	0.09	0.13	0.30	0.44	1.00										
Law and order	0.62	0.56	0.69	0.38	0.67	0.45	-0.13	0.60	0.09	0.46	-0.28	0.59	0.00	-0.05	-0.51	0.02	0.58	0.67	0.62	0.49	0.47	0.74	0.39	1.00									
(ln) Military exp.	-0.02	-0.04	-0.01	-0.10	0.02	-0.02	0.01	-0.03	-0.10	0.13	0.18	0.13	-0.05	-0.20	-0.05	0.00	0.03	-0.03	0.03	-0.23	-0.29	-0.14	-0.02	0.05	1.00								
Manuf. share	0.16	0.11	0.21	0.33	0.21	-0.12	-0.06	0.41	0.16	0.31	-0.33	0.32	-0.15	0.11	-0.24	-0.07	0.22	0.26	0.24	0.25	0.23	0.22	-0.02	0.19	-0.10	1.00							
Regime type	-0.32	-0.30	-0.42	-0.33	-0.43	-0.17	0.20	-0.40	-0.23	-0.22	0.50	-0.28	0.11	-0.11	0.35	0.06	-0.22	-0.48	-0.40	-0.66	-0.34	-0.30	0.01	-0.33	0.33	-0.23	1.00						
Years in Office	-0.06	-0.09	-0.15	-0.22	-0.12	-0.04	0.08	-0.17	-0.10	-0.07	0.27	-0.04	0.05	-0.13	0.06	0.07	0.00	-0.15	-0.18	-0.40	-0.13	-0.05	0.03	-0.08	0.21	-0.23	0.45	1.00					
Physical integrity	0.58	0.51	0.56	0.13	0.53	0.31	-0.21	0.41	0.03	0.32	-0.26	0.39	0.13	-0.03	-0.36	-0.06	0.49	0.52	0.51	0.46	0.41	0.60	0.16	0.56	-0.16	0.05	-0.38	-0.12	1.00				
Oil energy use	-0.22	-0.14	-0.18	-0.24	-0.17	-0.18	-0.12	-0.30	0.17	-0.06	0.22	-0.13	-0.24	-0.18	0.06	0.04	-0.12	-0.20	-0.15	-0.16	-0.22	-0.17	-0.04	-0.22	0.14	-0.11	0.22	0.20	-0.17	1.00			
Alt./nuc. energy use	0.17	0.19	0.26	0.24	0.20	0.12	-0.15	0.16	-0.09	0.17	-0.25	0.05	0.10	0.14	-0.12	-0.05	0.13	0.18	0.19	0.29	0.22	0.19	-0.02	0.17	-0.10	0.19	-0.27	-0.18	0.22	-0.32	1.00		
Fossil fuel use	0.52	0.42	0.45	0.17	0.56	-0.10	-0.10	0.55	0.09	0.59	-0.17	0.80	-0.10	-0.14	-0.59	-0.01	0.39	0.37	0.23	0.17	0.13	0.33	0.22	0.37	0.22	0.35	-0.10	0.02	0.18	0.10	###	1.00	
Road energy pc	0.71	0.57	0.63	0.21	0.72	0.55	-0.18	0.51	-0.04	0.57	0.06	0.66	0.08	-0.18	-0.53	-0.01	0.55	0.52	0.40	0.28	0.18	0.37	0.23	0.51	0.00	-0.03	-0.16	0.02	0.43	-0.16	0.05	0.40	1.00