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Determinants of Ecological Footprints: What is the role of globalization?

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ABSTRACT

This paper empirically analyzes the ecological consequences of globalization, by employing the Ecological Footprint (EF) as a proxy for human ecological demands and the KOF index of Globalization. We develop an unbalanced data set covering 146 countries over the 1981–2009 period and are thus able to address the influence of countries' development over time. After empirically showing that globalization is an explanatory factor of ecological demands, an Extreme Bounds Analysis (EBA) identifies a robust set of impact factors. Subsequently, specific hypotheses on economic, political, social and overall globalization guide the empirical analysis. The findings suggest that economic globalization drives the EF of consumption, production, imports and exports. Social globalization correlates negatively with the EF of consumption and production, while increasing the EF of imports and exports. No effects are found for political globalization while overall globalization is positively correlated with EFs of imports and exports. The findings show that globalization may have different effects on EFs depending on the dimension (consumption, production, exports and imports) referred to.

1. Introduction

According to the *Ecological Footprint Atlas* (Ewing et al., 2010), we have lived in a state of ecological overshoot since the 1970s, which means that human demands have exceeded the Earth's biocapacity (WWF, 2014).[1] Human demands measure the ecological assets that a given population requires to produce the natural resources it uses and biocapacity refers to the productivity of those ecological assets (WWF, 2014). Human demands alter ecosystems by creating ecological pressures such as land-use changes, resource extraction and depletion (such as 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, for instance, famine, water shortages, and competition over resources (Field et al., 2014).

The same period has been marked by increasing globalization, which is defined, as "*the growing interconnectedness and inter-relatedness of all aspects of society*" (Jones, 2010).

Discussing the relationship of these developments, many scholars have no doubt about the co-evolution of (economic) globalization and the degradation of the global environment. This is highlighted by Borghesi & Vercelli (Borghesi and Vercelli, 2003), who state that "*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.*" On the other hand, claims exist that "*globalization is in fact good for the environment*" (Stern, 2004). Previous empirical work on the relationship between globalization and environmental pressures in many cases assesses one single dimension of globalization, such as the level of trade openness, and/or focuses on single environmental pollutants (Antweiler et al., 2001; Cole, 2004; Dreher et al., 2008; Lamla, 2009; York et al., 2003a), neglecting the broadness and multi-dimensionality of both globalization and of demands on the environment. Globalization, for instance, is more than just trade and operates across the social, economic, cultural and political domains. Adding multi-dimensionality, we define contemporary globalization as "the intensification of cross-national interactions that promote the establishment of trans-national structures and the global integration of cultural, economic, ecological, political, technological and social processes on

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[1] 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, B., Moore, D., Goldfinger, S., Oursler, A., Reed, A., Wackernagel, M., 2010. Ecological Footprint Atlas 2010. Global Footprint Network, Oakland.

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Table 1
Summary of hypotheses and key arguments (own elaboration).

Hypotheses	Description	Key arguments
(1) Intensification	Economic globalization intensifies human (ecological) demands	• Growth of ecologically intensive production and consumption • Intensification of agricultural production and energy use • Avoidance of footprint mitigation to safeguard objectives
(2) Markets for the global environment	Economic globalization decreases human demands	• FDI drives transfer of clean technologies and leapfrogging • Enhanced allocative efficiency and private-property rights lead to internalization of externalities
(3) Global environmental governance failure	Political globalization intensifies human demands	• No effective institutions in place to govern global ecological issues • Global governance suffers from lack of democracy, accountability and transparency
(4) Global environmental governance	Political globalization decreases human demands	• Enhancing capacity and effectiveness of governance institutions
(5) Living in denial	Social globalization intensifies human demands	• Physical and cognitive distancing leads to a lack of awareness, concern and necessary behavioral changes
(6) Global environmental awareness	Social globalization decreases human demands	• Exposure to information, education and knowledge

global, supra-national, national, regional and local levels" (Rennen and Martens, 2003).[2] Employing multi-dimensional indicators of both trends (increasing human demands and globalization) provides the possibility of systematically assessing this complex relationship without risking problems of multicollinearity and omitted variable bias in empirical work (Dreher et al., 2008).

This is where our paper adds to the literature. The question is "*to what extent does globalization and its different domains intensify environmental footprints and/or contribute to ecologically sustainable development?*" (Figge et al., 2016). The development trajectory can be deemed ecologically sustainable if it is reversing the process of ecological overshoot. Figge et al. (2016) conclude that globalization in its current form contributes to increasing pressures on the ecological environment and therefore does not contribute to reconciling human demands with the Earth's carrying capacity. We address this question by extending the analysis from one point in time (Figge et al., 2016) to a panel data set. We cover the period 1981–2009 for up to 146 countries and are thus able to control for countries' development over time (by including time and country fixed effects). By using the Granger causality test (Granger, 1969), we show that globalization indeed determines the level of demand on the environment, and that we are not confronted with the dangers of reverse causality. Further, we test 28 demographic, economic, geographic, cultural and political variables that, it has been suggested, affect human demands and pressures on the environment in order to identify robust control variables (for details and references see Appendix A2). For this, we apply a variant of the Extreme Bounds Analysis (EBA) suggested by Sala-i-Martin (1997), Sturm and De Haan (2005) and Gassebner et al. (2011). Last, we address reverse causality issues, which may spuriously bias our results.

The remainder of this paper is organized as follows. In Section 2 we relate to the relevant literature, provide theoretical considerations for our hypotheses, and develop testable hypotheses. Section 3 explains the concept and empirical operationalization of human demands on the ecology as well as of globalization. Subsequently, we explain the EBA to identify robust determinants of these demands. Then, we specify the econometric model. The results are presented and discussed in Section 4. Section 5 concludes and discusses the relevance of the results for global decision-making processes.

2. Literature review and hypotheses

Addressing the relationship between multi-dimensional globalization and ecological footprints or ecological sustainability has not so far been a central question in the quantitative empirical literature on the consequences of globalization. Apart from the study by Figge et al. (2016), who use the Maastricht Globalization Index (MGI) at one point in time, a recent survey of more than 100 studies using the KOF Index of Globalization (described in Section 3.2) shows that the effects of globalization on the natural environment have been neglected in this field Potrafke (2014). To our knowledge, there has been no peer-reviewed study that systematically analyzes the environmental consequences of globalization over time, addressing endogeneity concerns. Many ecological studies, however, have shown that trade plays a significant role in changing land-use, in the displacement of people and in pollution, driven by human demands (Caro et al., 2014; Lambin and Meyfroidt, 2011; Peters and Hertwich, 2008; Weinzettel et al., 2013).

We expect that globalization has an effect on the demands humans place on the environment, since globalization captures global developments and interactions, including international trade, that go beyond the standard drivers such as affluence, population and technology. Most closely related to our study is the one by Dreher et al. (2008). Employing panel data, the authors show that globalization is correlated with a decrease in sulfur dioxide emissions and water pollution, and find no effect on roundwood production and carbon dioxide. For economic globalization, the study found a small increasing effect on roundwood production; social globalization has a small and positive effect on the emissions of carbon dioxide, and political globalization is shown to decrease water pollution. Lamla (2009) investigates robust determinants of pollution (carbon dioxide, sulfur dioxide and biochemical oxygen demand) and considers, among other factors, overall globalization as an explanatory variable. However, he does not disentangle the different dimensions of globalization, and focuses on long-term effects by considering cross-country differences. He finds differing correlations for different pollutants in the long-run: positive (increasing) for carbon dioxide and negative for sulfur dioxide and biochemical oxygen demand (Lamla, 2009). In contrast, we analyze explicitly the different dimensions of globalization (economic, social and political) and focus on the immediate impacts on human (ecological) demands within the countries over time.

We now turn to arguments why and how the different dimensions of globalization may impact human demands to formulate hypotheses. An overview of all hypotheses and arguments are detailed in Table 1.

2.1. Economic globalization

Economic globalization can lead to the growth of more pollution-intensive industries in countries with lower environmental regulations, which is the case in many developing countries (Copeland and Taylor,

[2] For a more elaborate discussion of the different dimensions of globalization and how those are actually measured we refer the interested reader to Rennen and Martens (2003) and Martens et al. (2015).