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Wealth and pollution inequalities of global trade: A network and input-output approach

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ABSTRACT

We examine distributions of pollution and wealth among countries over a 20 year period. We distinguish between pollution produced within a country and pollution triggered along global supply chains by a country's consumption. We explain pollution and wealth distributions via network characteristics. Our findings show a positive, (log-) linear relationship between a country's network position and both ways of accounting for pollution. In addition, core countries and/or ones with higher numbers and volume of export ties increase their shares of global wealth faster than shares of pollution.

1. Introduction

The interconnectivity of our international trade ties implies that activities, events, and behaviors in one part of the world can trigger (uneven) consequences around the globe. These consequences take a variety of forms, and in this paper, we focus on two: wealth and pollution. As way of an example, when a person purchases a toothbrush in the USA, this purchase triggers a chain of production activities around the entire globe. Some parts hail from Asia, others from Europe, and all get shipped to Northern America for assembly. At each step in this global supply-chain, value added is created and pollution occurs, be it through resource extraction, manufacturing or transportation processes. Furthermore, these gains in wealth and pollution are experienced differently by different countries.

In this paper, we examine the uneven distributions of pollution and wealth among nation-states as conditioned by patterns in global trade relations. In looking at pollution, we consider not only pollution produced within a country via manufacturing and consumption activities (what we refer to as *production-based* pollution) but also pollution triggered throughout global supply chains by a country's consumption of pollution-intensive commodities (referred to as *consumption-based* pollution). We use this dual-approach to trace how pollution emissions associated with production activity *can also be understood* in relation to the final consumption activity of households, governments and investors. In thinking through issues of environmental fairness and responsibility in the context of a globalized world, such a dual-approach enables one to understand pollution as a shared responsibility

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between consumers and producers (Lenzen, Murray, Sack, & Wiedmann, 2007).

In examining the distributions of pollution and wealth, we try to explain these differences by considering a number of network characteristics, namely countries' positions within the overall, global trade network, and their network centrality. By 'position' we mean where a country is situated within the overall structure of the network. By centrality, we refer to the quantity and volume of ties and distinguish between outdegree centrality, which is based on outgoing ties, or export flows (i.e. the number of export partners and amounts of exports), and indegree centrality, which is based on incoming ties, or import flows (i.e. the number of import partners and amounts of imports). Our consideration for network position and centrality stems from a number of studies that have similarly considered the importance of global trade network features in discussing economic globalization and/or 'economic integration' (Kali & Reyes, 2007; Reyes, Schiavo, & Fagiolo, 2010; Yu, Feng, & Hubacek, 2014). In general, we agree with these scholars that ignoring features of global trade networks downplays the complexity of structural features of economic globalization.

We also draw inspiration from global network studies showing how a country's position within a global trade network can condition a variety of outcome variables, including its economic development (Clark, 2010; Kali & Reyes, 2007; Mahutga & Smith, 2011; Smith & White, 1992) and pollution (Burns, Davis, & Kick, 1997; Prell, Feng, Sun, Geores, & Hubacek, 2014; Prew, 2010). Yet with regards to pollution, these network studies fail to take a dual-approach to looking at pollution, focusing either on production-based pollution (Burns et al., 1997; Prew, 2010) or consumption-based pollution (Prell et al., 2014).

The rest of the paper is structured as follows: we offer a review of the literature looking at air pollution, wealth, and international trade. This is followed by a description of our longitudinal data, which includes country-by-country trade data on the sector level, as well as a number of country-level covariates. We discuss our methods, which include social network analysis (SNA), to measure the extent to which countries are integrated into the world economy, multi-regional input-output (MRIO) analysis to calculate consumption and production-based SO_2, and panel data regression models and estimation techniques to measure how network measures of economic integration can predict differing outcome measures of pollution and wealth. We conclude with a discussion and reflection of the study, highlighting our methodological and substantive contributions.

2. Global trade as a complex system

International trade is often described as a system of increasing interdependent economic relations (e.g. Dick & Jorgenson, 2010; Kali & Reyes, 2007; Nissanke & Thorbecke, 2006; York, Rosa, & Dietz, 2003). These economic relations can form patterns, giving rise to structural features that shape characteristics and outcomes for countries. For example, an economic tie may or may not exist between two countries, and this tie's presence or absence could have a potential impact on levels of pollution, wealth, or both for either country. A similar sort of statement could be made regarding whether or not two countries are mutually tied to a third via some trade relation. These simple examples illustrate how the network of trade ties surrounding a country can potentially affect its wealth and/or pollution levels.

A number of studies exist that adopt a network approach to studying international trade relations (Breiger, 1981; Clark, 2010; Kali & Reyes, 2007; Mahutga, 2006; Mahutga & Smith, 2011; Sangmoon & Shin, 2002; Smith & White, 1992; Su, 1995; Yu et al., 2014). Some of these studies use network measures to describe the entire network structure, and in doing so, attempt to gauge the extent to which the global economy has become integrated overtime (e.g. Kali & Reyes, 2007; Sangmoon & Shin, 2002; Su, 1995; Yu et al., 2014). Other studies consider how individual countries are conditioned by their position within this global trade network (Clark, 2010; Kick & Davis, 2001; Kim & Shin, 2002; Mahutga & Smith, 2011), and/or their level of centrality (Prew, 2010). Here, an important distinction is made between countries that are positioned in the network 'core' versus its 'periphery.' In network terminology, a core-periphery structure refers to a two-class partitioning where the core consists of a set of actors (or nodes) that are densely connected to one another and central to the entire network, i.e. they form a well-integrated block and share a similar set of ties to others in the network. In contrast, the periphery refers to a class of countries that are more or less isolated from one another and linked to the rest of the network mainly via ties to the core.

Within this core-periphery structure, core countries are inclined to accrue more benefits, largely in the form of economic growth (e.g. Clark, 2010; Mahutga & Smith, 2011; Smith & White, 1992), whereas peripheral countries tend to accrue a larger share of global environmental costs in the form of deforestation (Burns, Kick, & Davis, 2003), carbon-dioxide (Prew, 2010), greenhouse gas (Burns et al., 1997) and/or sulfur-dioxide pollution (Prell et al., 2014). This unequal distribution of benefits and costs is seen, moreover, as arising from the 'ecologically unequal exchanges' between core and non-core countries (e.g. Hornborg, 2011; Jorgenson, 2011). Here, financial investment and/or high-value goods flow from the wealthy core in exchange for undervalued goods produced in, or extracted from, the periphery. In the process, non-core countries absorb the lion's share of environmental costs associated with dirtier production activities and/or the use of environmental space needed to meet core demands (Grimes & Kentor, 2003; Jorgenson, 2012; Jorgenson & Clark, 2009; Moran, Lenzen, Kanemoto, & Geschke, 2013; Rice, 2007; Yu et al., 2014). Further, as the regimes of more peripheral nations look for economic opportunities to move into the core, they tend to relax environmental (and labor) criteria to encourage the relocation of (often pollution-intensive) manufacturing activities from core countries to their own (Copeland & Taylor, 2004; Grimes & Kentor, 2003; Hornborg & Jorgensen, 2010; Leonard, 1985, 2006), thus perpetuating the negative environmental impacts associated with their trade patterns with the core.