



Modeling governance and water pollution using the institutional ecological economic framework



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ABSTRACT

This paper investigates the effect of governance on levels of water pollution for all industrial activities as well as by some specific industry category in a sample of OECD economies. Using an institutional ecological economic conceptual framework, the effects of several measures of governance are empirically examined. Our findings reveal that the rule of law, regulatory quality, control of corruption, government effectiveness and voice and accountability are negatively and statistically significantly correlated with water pollution across all industrial activities as well as specific industry groups. We conclude that governance matters for mitigating industrial water pollution. This novel paper adds to the existing literature on industrial water pollution by developing a modeling approach that empirically examines questions that have so far not been explored in institutional ecological economics and demonstrates the importance of the framework for addressing real life ecological problems that are common across the world. Policy implications are drawn.

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1. Introduction

This paper investigates the impact of country level governance on water pollution levels by all industrial activities as well as specific industry categories in a sample of the OECD economies. Using an institutional ecological economic conceptual framework (for example, Paavola, 2007; Paavola and Adger, 2005), five measures of governance—the rule of law; regulatory quality; control of corruption; government effectiveness; and voice and accountability; are chosen and their effects on water pollution are tested using cross-country data. In examining this relationship, the empirical analysis uses the generalized methods of moment estimation and tests several models of water pollution by all industrial activities as well as by specific groups of industries.

Water pollution has long been considered in the economic literature, but with a limited number of approaches. Complementary to this, governance research has progressed significantly during the last two decades. In addition, ecological economics has developed new approaches to address challenges of environmental management. This paper takes analysis forward by building on these three stands in the literature in order to empirically examine questions that to date have only

been addressed conceptually in the institutional ecological economic literature.

Our work makes several new specific contributions to the ecological economic literature in terms of understanding the role of governance in mitigating water pollution. First, it focuses on water research, an area of research that is highly relevant from an ecological economic research perspective. Second, it examines the effect of five dimensions of governance on water pollution so as to identify the magnitude of the effect of specific aspects of governance on water pollution with greater strength and meaning. Third, it adopts a theoretical conceptual framework of institutional ecological economic drawing on a body of literature from the new institutionalist school of thought. Finally, this study is based on a sample of industrialized countries that have established institutional and legislative frameworks needed to make such measures effective. The findings of the industrialized countries can signal to other countries, particularly, the industrializing developing economies (with limited experience in pollution control measures) to set up relevant strategies and measures to control water pollution.

The rest of the paper is structured as follows. The next section discusses relevant issues pertaining to water quality and presents the conceptual framework and outlines an analytical model. The choice of variables and their theoretical justification are explained in Section 3. Section 4 discusses variable measures and sources of data. Section 5

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presents the empirical findings together with its interpretation. Section 6 presents a discussion of the findings and its relevance to the institutional ecological economic literature. Section 6 concludes.

2. A review of the literature

The quality of fresh ground water is vital for the natural ecosystems; household needs; and the demands of industrial and agricultural production activities. Access to safe drinking water is a human right and unsafe or contaminated water threatens both the natural ecosystem and places human health at a substantial risk (World Health Organization, 2012). Water is considered to be contaminated when there is an alteration of its characteristics and conditions in such a way that it is inadequate or less suitable; and it cannot meet the purposes to which it is destined if it were in its natural state (Grigg, 2011).

The most relevant sources of contamination or pollution of water are human population, industry and agricultural practices (Jain and Singh, 2010). Other than the adverse effects of natural disasters (hurricanes, floods, tsunamis, earthquakes, volcanic eruptions and landslides) a significant proportion of the contamination and degradation of water quality is a result of human activity: the discharge of pollutants from point sources (sewers, waste water treatment plants and factories) and non-point sources with low pollutant concentration sources covering large areas (World Bank, 2003) that directly influences the hydrologic cycle (reviewed thoroughly in Peters and Meybeck, 2000). Wastes distributed over larger areas such as fertilizer, weedicide and pesticide applications to cropland are referred to as non-point or diffuse sources (Peters and Meybeck, 2000). These authors also note that diffuse sources also include several point sources distributed over a larger area such as residential septic tank effluents from multiple dwellings and multiple building construction sites in a developing area. Pollutants may include the presence of suspended particulate matter that can have a range of detrimental effects on water resources including adverse esthetic impacts, higher costs of water treatment, a decline in marine resources and serious ecological degradation (Bilotta, et al., 2012).

Pollution from industrial operations is significant in that it is not only damaging to the ecology but also rendering it inadequate for re-use or recycling. You et al. (2009) observed that in China, factories are able to discharge up to 36 billion tons of untreated waste water into rivers, lakes and coastal waters annually with devastating effects on water quality. According to Tortajada and Islam (2011), in Asia, surplus nitrogen and phosphates from agriculture are projected to increase significantly in both China and India, driven mostly by increased use of fertilizers as well as poor water management practices. Zeid and Biswas (1990) observed increasing contamination of groundwater by agricultural chemicals in areas that are intensively farmed.

Scientifically, assessing water quality in terms of its safe use has been difficult to achieve because of insufficient and poor monitoring prior to changes in water quality due to human activities as well as statistical shortcomings in highly populated areas (Grigg, 2011). However, available statistics reveal that the livelihoods of millions of people around the globe are threatened by poor water quality. For example, in 2010, 783 million people around the globe continued to use non quality assured sources to meet their drinking water needs (World Health Organization, 2012) while Jain and Singh (2010) note that the limited availability of safe fresh water is reaching critical levels in the Middle East and North Africa where per capita availability is presently 1250 cubic meters per year as opposed to 23,000 cubic meters in Latin America. The world's consumption of water is rising as a direct result of world population growth as well as rapid industrial expansion in large developing economies such as China, India, Brazil and Russia, directly threatening the availability of fresh water. In particular, the food industry is characterized by high water consumption per ton of food product produced and it is also a major user of fresh water accounting for approximately fifty percent of total water usage (Casani et al., 2005).

Given the extent of population, agricultural and industrial usage as well as contributions to water pollution by human activity, agriculture, industry; the governance of water resources is of critical importance for maintaining safe water and minimizing the effects of detrimental behavior. Reforms aimed at increasing production and growth at the national and global levels cannot be divorced from policies that prevent the contamination of resources such as ground water, among others. The strength of the existing scientific analysis is exposing the causes and the magnitude of water pollution and its impact on the environment. It has been helpful for setting emission limits and guidelines for discharges. However a weakness of this literature is that many of the water pollution studies on contamination, saving, recycling and re-use are largely technical, of relevance to scientific audiences but of limited value for policy and improved decision making.

This study shifts the focus of attention from scientific guidelines to economic efficiency and the incorporation of new institutional parameters particularly in terms of effective control of water pollution. Reducing water quality concerns and improving the governance of global environmental resources are global priorities and clearly based on multi-level solutions simultaneously operating at the national, international and intermediate levels (Paavola, 2007). Hence, the need to incorporate an institutional dimension to scientific analysis of water pollution. The two approaches are complementary. Governance concerns include a broad set of enabling and regulatory functions that support and oversee the resources used to manage water for human and environmental needs. Further the research literature on water pollution built on welfare economics has largely addressed environmental problems as externalities following the Pigouvian approach. Despite the value of this approach further insights can be gained from the institutional ecological framework based on the concept of interdependence rather than of an externality. Further this approach has the capacity to incorporate behavior motivated by ethical and social norms and not just financial optimizing. Paavola (2007) has argued that the Pigouvian approach has typically failed to recognize externalities as instances of interdependence. The quality of institutions appears to matter when it comes to ensuring that the water quality is preserved. This makes a convincing case to investigate if and how governance matters, particularly in terms of mitigating industrial water pollution. The discussion below establishes the conceptual and analytical framework to address the effect of governance on water pollution.

There is a common agreement among institutional researchers that the quality of institutions matters for countries' long-term growth and development. Olson (1996) argued that while the industrialized countries seem to have achieved most of their potential in good governance; the developing countries still lag behind as institutions in this category of countries are still undeveloped. Charron et al. (2012) believe that it is the fundamental process of state formation that explains much of the cross-country variation of institutional quality and economic and social outcomes today. Baumol and his co-authors (Baumol et al., 2007) have argued "our own thinking on the subject of economic growth has been strongly influenced by the institutional school of economic growth." New institutionalists such as Williamson (1975), Olson (1996), Olson et al. (2000), Rutherford (2001), North (2005), and Acemoglu et al. (2005), among others, argue that institutions are fundamental to the effective functioning of market-based economies. According to North (2005), the institutional structure is a combination of formal rules (constitutions and laws), informal constraints (norms of behavior, conventions, codes of conduct), and their enforcement characteristics.

Within the new institutional economics, there is an emerging body of literature addressing local and international environmental concerns, hereby referred to as the institutional ecological economics. Some of the contributions to this body of research are from Bromley (1992), Schlager and Ostrom (1992), Dietz et al. (2003), Ostrom (2005), Paavola and Adger (2005) and Paavola (2007). This emerging body of research interfacing the disciplines of economics, political science, law and sociology and anthropology seeks to resolve misunderstandings

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