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The industrial dynamics of water innovation: A comparison between China and Europe

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ABSTRACT

The expansion of the green economy agenda has increased the attention on eco-innovations globally, with issues related to water stress identified as one of the major bottlenecks for sustainable economic growth. Using evolutionary economic theory, this study investigates the industrial dynamics of the water sector, comparing China and Europe using patent data. This comparison feeds into the "catching up" literature, addressing the challenges of the "green economy" agenda in different regions in various stages of development. We highlight the neglected micro-dynamics of water innovation, investigating the roles of different innovators in the development of water technological trajectories, with a special focus on water innovations closely related to climate change adaptation and mitigation technologies. Public water innovators (universities) were found to be more important in China than in Europe. Similarities were also identified between Europe and China; big companies were found to be the main innovative leaders with no substantial changes documented over the timeframe investigated. Overall, the finding implies a rapid Chinese technological catching up of water technologies in the last three decades, where our research has pointed towards the role of redirection of Chinese policies with a stronger focus on sustainable development. The analysis, overall, sheds light on the state and nature of the globalizing green growth agenda.

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1. Introduction

Water is designated as a "critical resource" and rising problems with securing water supply and handling of wastewater is turning the water agenda into an area of high corporate and policy attention (OECD, 2011a). According to Organization for Cooperation and Development (OECD) (2012), the total water demand is projected to increase by 55% by 2050 due to growing demand from both manufac90turing (+400%) and domestic sectors (+130%). Moreover, this threatens the capacity to find a balance between the right to extract and use water that impacts land-use development as well as water for ecosystems, the

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latter also being a competitor, in a sense, for this resource (Acreman, 2001). This scenario is likely to increase the competition for this resource among domestic users, industry, and agriculture (OECD, 2012a, b).

In recent years, the importance of eco-innovation in enabling the transition towards global sustainable development is increasingly being recognized; compare the topical UN sustainable development goals (2012). Thus, eco-innovation has become an important contributor to not only environmental benefits, but also economic development (Kemp & Pearson, 2007; Kemp, 2010; Andersen, 2008; O'Brien et al., 2014). Still more countries are developing strategies for green growth, and while this trend started in the developed economies, many emerging economies like China (since 2005) are increasingly committed to the green growth agenda (OECD, 2009, 2011b, United Nations Environmental Program (UNEP), 2011).

Evolutionary economic theory emphasizes not only the dynamic nature but also the time and space dependencies of economic development (Dosi, 1982; Dosi, Freeman, Nelson, Silverberg, & Soete, 1988; Nelson & Sidney, 1982). Within this framework, innovation systems theory argues that despite rising globalization, countries and regions tend to display different innovation patterns (Cooke, Gomez Uranga, & Etxebarria, 1997; Lundvall, 2007; Schaaper, 2009). The objective of this paper is to compare the water innovation patterns of China and Europe. We seek specifically to identify and characterize the key water innovators[1] in both Europe (an early mover on eco-innovation) and China (a late mover on eco-innovation). In comparing Europe and China, we feed into the emerging "green catching up" literature (e.g., Peuckert, 2013). In this context, the first research question is whether China presents different innovative patterns in the water sector as compared to Europe. Our related hypothesis is that China may perform differently from Europe due to a historic high degree of central planning in the Chinese economy.

Europe has been a pioneer in eco-innovation (Eco-Innovation Observatory (EIO), 2011; United Nations Environmental Program (UNEP), 2011), specially within the water sector (OECD, 2014). In contrast, China has only recently taken on the eco-innovation agenda on a large scale, having developed the necessary policies supporting eco-innovation more widely (Cai & Zhou, 2014; Weng, Dong, Wu, & Qinv, 2015) and noticeably stricter water policies. These policies have come about as the country is facing urgent water challenges, many of which are similar to those Europe has already faced or is still facing but often the magnitude and scale is much larger (China Water Risk, 2017). China's innovation system is influenced by its historically communist political structure. Accordingly, it has very strong planning powers and long-sighted strategizing but weaker market mechanisms, although the latter have been considerably strengthened in recent years (Guan & Yam, 2015; Schaaper, 2009). The strong planning powers may be favorable to environmental policy-making once given priority and particular water innovations that entail strong planning elements due to large investments in infrastructure. A related second hypothesis is that China may become a fast mover on eco-innovation, especially water innovation. This is, however, likely to depend on the degree to which China is willing and able to develop its own water companies and related capabilities as opposed to relying on imported goods and services (Deng, 2009).

In order to compare the innovation performance and dynamics of Europe and China, we investigate the micro-dynamics of water innovations underlying the National Innovation System (NIS) co-evolutionary processes, so far little analyzed. Based on evolutionary economics theory, we focus in this paper on identifying who the water innovators are, based on patent data, analyzing the similarities and dissimilarities between Europe and China. We distinguish between private water companies and public knowledge institutions. We further investigate different innovators' role in the development of different water technological trajectories, identifying whether or not companies and knowledge institutions present similar innovative patterns in Europe and China. A secondary research question is hence to inquire into the possible specific characteristics of water innovation. Related to this, the third hypothesis is that public water innovators are more important in China than in Europe. The related hypothesis is that the role of public planning and involvement in water innovation will affect the direction of water innovation by prioritizing specific areas.

In order to develop this analysis, we have divided the water innovations into different categories. We recognize that different taxonomies of eco-innovation exist (Andersen, 2008; Horbach, 2005; Horbach, Foxon, Kemp, Steward, & Andersen, 2005; Kemp & Arundel, 1998) but have departed from them, instead proposing speculatively, to test a new taxonomy specifically directed at water innovations. We suggest two distinct groups: The first group contains those water innovations that are strongly eco-innovative or "green," i.e., innovations that are closely related to climate change adaptations and mitigation technologies.[2] The second grouping contains water innovations defined simply as "general water innovations" and are mainly related to innovations covering water distribution, water supply, and sewage distribution and treatment, that is, more traditional water solutions. We use patent classifications to situate specific water innovations in the different groups.

In a sector that has huge environmental importance, and where all water innovations historically and statistically have been considered as eco-innovations, that is, as a part of the "environmental sector"' (e.g., Eurostat, OECD), this is quite controversial, in part because the suggested delimitation between the green and not-green water innovations is not straightforward. Nonetheless, we investigate whether this division may shed light on important dynamics with respect to the application of detailed patent analysis methodology.

[1] This paper is not able to capture the role of utility companies within the innovative dynamics and also non-patentable innovations that may take place, especially in rural areas.

[2] More precisely: Water recovery and recycling technologies, pollution control technologies, water saving technologies, and greywater technologies as defined in the patent classifications we shall return to.

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