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Green product development: What does the country product space imply?

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ABSTRACT

This paper contributes to green product development by identifying the green products with the highest potential for growth in a country. To address our aim, we use the concept of product proximity and product space and, borrowing from the results of recent studies on complexity economics, we advance that the green products with the highest potential for growth among all green products in a given country are those being in close proximity to the products a country produces with high Relative Comparative Advantage (RCA). We test this hypothesis performing a regression analysis. We build the product space for 141 different countries for the years between 2005 and 2013 and for each country we compute the maximum proximity of each green product to the products with high RCA (i.e., the proximity of the product source of competitive advantage closest to the green product considered). Results confirm that green products with high maximum proximity to the products with high RCA had the highest growth. So doing, we contribute to the literature by providing a new application of the product space as a policy making tool for green development. We also provide several applications of the proposed method.

1. Introduction

The world population has grown by one billion in the span of the last twelve years, reaching today 7.3 billion people, and it is growing at a rate of 1.18% per year, i.e., an additional 83 million people annually (UN, 2015). This growth has been accompanied by a huge increase in the amount of natural resources extracted, to an extent never seen before (Krausmann et al., 2009; Wiedmann et al., 2015). In fact, natural resources are essential inputs for production processes supporting the needs of a growing population and the extraction, treatment, and disposal of such resources are an important source of income and jobs in many countries. In addition to their fundamental role in industry, natural resources are also part of the ecosystems that support the provision of services such as climate regulation, flood control, natural amenities, and cultural services. In this regard, the high consumption of natural resources can cause huge damages to the ecosystem, such as global climate change, landscape change, and loss of biodiversity (e.g., Donohoe, 2003; Weber et al., 2008).

The scenario thus outlined shows that the world today is facing two main challenges: on the one hand, expanding the economic opportunities for a growing global population, but on the other hand, addressing the environmental pressures which, if left unaddressed, could undermine the ability to seize these opportunities. The way to address both these issues at the same time is to promote an environmentally sustainable economic growth (UNEP, 2011). Such an economic growth has been defined as "green growth":

> *"Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies"* (OECD, 2011).

Green growth can be promoted by applying multiple strategies, such as decarbonizing the economic systems forcing firms to adopt cleaner production processes (UNEP, 2004) as well as supporting the development of green products. In June 2009, the OECD Council Meeting at Ministerial Level adopted a Declaration on Green Growth, which invited the OECD to develop a Green Growth Strategy aimed at promoting the development of green sectors (OECD, 2009), i.e., those sectors able simultaneously to contribute

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to economic growth in the short term and to help reduce environmental pressures in the long term (Gazheli et al., 2016; de Bruyn, 2002; Porter and Van der Linde, 1995; Williams and Millington, 2004). Green products are in fact designed with the aim to reduce the environmental impacts of their design, manufacture, use, and disposal (Berchicci and Bodewes, 2005). In a recent study, Chen et al. (2017) show that in China the green sectors produce an important reduction of industrial pollution and at the same time contribute to the economic growth of the country.

To support the development of green products and meet both environmental and economic goals, it is important to analyze the factors fostering green product development. This issue can be addressed from both the demand and supply side. Literature has mainly focused attention on how to promote the demand for green products. In this regard, most of the studies have explored the marketing strategies aimed at influencing consumers' purchase behavior (e.g., de Medeiros and Ribeiro, 2017; de Medeiros et al., 2016; De Angelis et al., 2017; Ritter et al., 2015; Dangelico and Vocalelli, 2017), and the attitudes and the motivations of the consumers to buy green products (e.g., Biswas and Roy, 2015; Yu et al., 2017; Maniatis, 2016; Yadav and Pathak, 2016).

The supply side, concerning the aspects that can support firms to produce green products, has been less investigated. In this regard, the public sector plays a relevant role, because it can stimulate the economic actors to produce green products by means of adequate policy measures (Baumann et al., 2002; Wüstenhagen and Bilharz, 2006; Rehfeld et al., 2007; Fischer and Newell, 2008; Hamdouch and Depret, 2010; Nesta et al., 2014; Sonnenschein and Mundaca, 2016; Wang et al., 2016; Gazheli et al., 2016). However, designing effective government initiatives for green product development is a challenging task (Potts, 2010). Previous studies show in fact that policy measures might not be equally effective for all green sectors in every country (Eickelpasch and Fritsch, 2005; Pack and Saggi, 2006; Huberty and Zachmann, 2011). Furthermore, because of the limitation of economic resources, not all green products can be supported in a given country. Thus, one of the most critical challenges for the policy makers is the identification of those green products having the highest potential for growth, which therefore should be promoted through targeted policy actions. The relevance of the economic performance for assuring green product development is in fact widely recognized (Feng et al., 2017; Chen et al., 2017; Loiseau et al., 2016).

This paper addresses this issue by developing a method based on a recent tool coming from complexity economics, i.e., the *product space* (Hidalgo et al., 2007; Hidalgo and Hausmann, 2009). The product space shows the proximity among products, which in turns captures the similarity of the requisite capabilities to produce them. Products that require similar requisite capabilities are thus located in close proximity in the product space. The product space is also a useful tool to analyze a country's dynamics. In particular, it is shown that a country evolves by traversing the product space adding new products that are in close proximity to the products it already makes with high competitiveness compared with the other countries, i.e., those products with Relative Comparative Advantage (RCA) higher than one (Balassa, 1986). Therefore, the likelihood that a country will develop a particular product depends on how "near" that product is in the product space to the products that the country is already able to successfully make and export (Hidalgo et al., 2007).

In the green product context, the closer a green product is to a product with RCA>1, the more likely the country is to possess the requisite capability to produce that green product successfully, and thus the higher the probability is that the country will successfully introduce the green product within its product space. Based on this argument, we argue that green products closer to the products that a country produces with RCA>1 have greater potential for growth than those with low proximity. It follows that they are the best candidates for support through appropriate policy actions.

A similar intuition is proposed by Hamwey et al. (2013), who develop the "green product space methodology", an analytical approach allowing the green products for which a country is likely to be competitive in the world market to be identified, by computing their proximity with the products with RCA>1. The higher the proximity of the green product, the more competitive it should be. Hamwey et al. (2013) apply such a methodology to the product space of Brazil, built on export data of year 2009. However, they do not support their hypothesis by a statistical test. Furthermore, they do not specify a threshold value of proximity for which the green product can be considered enough close to be competitive. For this reason, their findings do not appear conclusive.

A further coherent argumentation is provided by Huberty and Zachmann (2011). They investigate whether, and in which countries, industrial policies aimed at supporting green development can improve the competitiveness of green products in export markets. In particular, they analyze the growth in RCA of two green products (wind turbines and solar cells) exported by European countries from 1996 to 2008 and sustained by national policy measures. They found that the only variable, among those investigated, positively affecting the growth of both the products is their proximity to products that are a source of competitive advantage for the country (RCA >1). In particular, the growth in RCA of a green product is higher for countries in which the green product had strong proximity to other products having RCA>1, *ceteris paribus*. This result is coherent with our hypothesis. However, the study was conducted for only two green products, so that this finding needs confirmation at a larger scale.

In this paper, we overcome these limitations. We conduct a regression analysis to test that the green products with the highest potential for growth among all green products in a given country are those being in close proximity to the products a country produces with high RCA. We build the product space for 141 different countries for the years between 2005 and 2013 and for each country we compute the maximum proximity of each green product to the products source of competitive advantage (i.e., the proximity of the product source of competitive advantage closest to the green product considered). Regression analysis confirms that a strong relationship exists between maximum proximity and growth in the export performance of green products.

Finally, we develop several applications of the concept of maximum proximity that might prove useful to both policy makers and scholars. First, we show how the concept of maximum proximity higher than a threshold value is a suitable tool to map and plan green product development, since it allows us to identify the green products to support by means of policy actions in any country on the basis of its productive structure. Furthermore, we use the concept of maximum proximity higher than a threshold value to analyze the diversification of the country's basket of green products and to investigate the role of geography in green product development, deriving interesting implications.

The paper is organized as follows. First, in Section 2 we present the theoretical background by assessing the concept of green products and presenting the product space methodology. In Section 3 the research methodology, the sources of data, and the regression analyses are presented. The results of the regression models are shown in Section 4. In the same Section, a discussion of some useful applications of the concept of maximum proximity is provided. The paper ends with conclusions in Section 5.