A Review Paper on Green Technology Fitness

Amit Kumar Shrivastav, Director

Department of Commerce & Management, Arka Jain University, Jamshedpur, Jharkhand, India

Email Id- amit.s@arkajainuniversity.ac.in

ABSTRACT: The current research examines empirical regularities in the evolution of green technology. We investigate innovations that may be linked to the ENV-TECH catalogue, which covers technology in environmental management, water-related adaptation, and climate change mitigation, using patent data. In addition, between 1970 and 2010, we used the Economic Fitness-Complexity (EFC) method to evaluate their evolution and geographical dispersion among nations. This enables us to classify nations into three categories: leaders, laggards, and catch-up. While there is a direct relationship between GDP per capita and invention capacity, we also document the remarkable growth of East Asian countries that began on the periphery and quickly became key players. While the relative development of individual areas may have peaked, there is now a demand for greater interoperability across green technologies as a result of this geographical pattern.

KEYWORDS: Climate, Economic, Fitness, Global, Green Technology.

1. INTRODUCTION

Academics and policymakers agree that speeding up the development of innovative low-carbon technologies and encouraging their worldwide adoption are critical, but not sufficient, measures toward limiting and avoiding greenhouse gas (GHG) emissions. To be clear, climate change is a global phenomenon with distinct local manifestations, implying that geographic regions vary considerably in terms of their susceptibility to climatic events as well as their capacity to react effectively to them. Indeed, although environmentally friendly technology develop mainly in industrialized nations, the need to reduce GHG emissions is greater in rising economies. Finally yet importantly, green technologies provide positive externalities in the form of improved environmental quality, in addition to the conventional negative externalities associated with non-appropriability and non-exclusivity of information[1]–[3].

These characteristics emphasize the significance of institutional circumstances in supporting or obstructing long-term economic development. Space-bound governance systems are critical for creating incentives for effective use of natural resources and environmental protection while reducing the risk of market failures. Because the production and spread of knowledge are based on the recombination of idea among actors with limited access to information and an imperfect ability to absorb, analyze, and react to it spatial characteristics are also important. Higher coherence across activities is anticipated to improve the probability of innovation since information transmission involves costs that grow with the variety of the associated knowledge base[4]–[6].

The main idea is that economic growth relies on local capacities to produce unique technical and industrial profiles. The composition of knowledge, or the quantity of underlying inputs and their interrelation, is a key driver of the uniqueness of these trajectories. The more complicated the areas to which this knowledge is applied, whether they be goods, industries, or technologies, the larger and more varied the spectrum of know-how. These patterns are clearly discernible based on empirical data.

First, the complexity of information generated varies significantly between geographical regions. Second, just a few regions excel in complicated activities, and this is typically correlated with their long-term economic growth. However, although investing in sophisticated technology is good in theory, many sectors simply lack the required competencies, and their underlying circumstances prohibit them from establishing a new path of growth. As a result, and last, these characteristics are dynamically self-reinforcing.

In this work, we use analytic methods established as part of the Economic Fitness-Complexity (EFC) approach to business prediction to evaluate the growth and geographical distribution of green technology from 1970 to 2010. EFC is a data-driven technique that was created to investigate the relationship between the makeup of nations' export baskets and their ability to grow their economies. This approach is based on the notion that in order for a nation to become viable in the production of a single item, it must first acquire the required abilities[7], [8].

However, the process of acquiring new capabilities is cumulative and path-dependent by its very nature, which is continuous with the fundamental intuition that complex products requiring advanced skills will be exported primarily, if not exclusively, by high fitness countries that will also be competitive in the production and trade of less complex goods. Capabilities are usually not visible, and in an ideal tri-partite network, they may be thought of as a latent intermediary layer between nations and goods. By analyzing the bipartite network of nations and exported products, several recent successful applications of EFC sought to extract information about the impacts of accumulated skills. These studies have demonstrated that the EFC algorithm has a high degree of accuracy in predicting a country's future development, as measured by its future per capita GDP. The algorithm's outputs include a ranking of nation fitness values, which represent how advanced each country's collection of capabilities is, and a ranking of product complexity values, which proxy how sophisticated the capabilities needed to create each product are. The method's satisfactory performance on empirical data has led to the creation of a diverse range of techniques and indicators based on the same principles. One of these derived measures is sector fitness, which is a simple version of the approach given by. This limits the study to a subset of similarly categorized goods and provides a glimpse of each country's strength in a particular industry. It is worth noting that the EFC technique is very adaptable. For example, instead of studying exported products, it has been successfully applied to study labor sectors another recent application of directly related techniques has been used to examine capability spillovers between patenting activity, scientific production, and country export profiles[9], [10].

Patent applications are used as a proxy for competence in this research. The main source is the European Patent Office's (EPO) Worldwide Patent Statistical Database (PATSTAT), which contains patent applications that can be traced back to the Organisation for Economic Co-operation and Development's (OECD) environment-related technologies catalogue (ENV-TECH) [22], which is organized into macro-domains like environment protection, water-related adaptation, and climate change. The rationale behind using the EFC method to this hitherto unstudied empirical setting is that the criteria for allocating patent applications to particular domains (i.e., technical classes) reveal features of the knowledge required for successful innovation.

The co-occurrence of technical classes in a nation, in particular, enables us to determine the degree to which innovations and associated skills are shared between countries. As a result, a nation with a diverse portfolio of technologies ranging from the most complex to the least complicated will be more fit, while complex technologies will feature almost exclusively in the portfolio of high-fitness countries. As a result, more specialized (or less diverse) nations tend to specialize in less complicated industries. In other words, low-fitness nations' portfolio of activities is (nearly) nested inside that of higher-fitness countries.

The juxtaposition of the above database and methodology yields proxies of environment-related creative activities that allow cross-country and cross-technology comparisons, keeping in mind the benefits and drawbacks of using patent data for the study of technology development.

The collection of metrics presented here, in particular, informs a rating of nations' tendency to develop new green technologies as well as their development. We provide insights into the extent to which each country contributes to the global network of technological capabilities, as well as the extent to which technologies grow and develop as a result of distributed inventive efforts, while remaining agnostic about the pathways through which countries develop and apply capabilities to environmental issues. Furthermore, we anticipate that a detailed map of who is creating and what they are inventing would add to the current discussion about leaders and laggards in the transition to sustainable communities.

A detailed analysis of the experiential governmental processes that shape the accumulation of innovative competences within countries—such as R&D, labor markets, and so on—and how this affects different work between countries is beyond the scope of this study and will be left for future research.

1.1 Supplies and Procedures:

1.1.1 Data:

The PATSTAT database of patent applications is the primary data source. We use patent classification codes to identify innovations in the area of environmentally friendly technologies under the OECD's ENV-TECH classification, which categorizes 94 green technologies using International Patent Classification (IPC) and Cooperative Patent Classification (CPC) codes.

Patent offices use the IPC and CPC, two widely used technology categorization systems, to categorize patent papers based on the technical areas in which they claim to be new.

At lower levels of aggregation, both systems include a hierarchical structure that explains the technical substance of the patents in ever detail.

We also use PATSTAT data on patent families, which are groups of patents that may be connected to one or more common ancestor patent papers. These collections, which constitute our unit of analysis, often include papers related to the numerous applications involved in protecting the same innovations in different countries. At least one ENV-TECH categorization code is given to 1,179,657 patent families (or 2,690,606 patent applications). The resultant data collection contains patent families (and the accompanying 1-digit ENV-TECH code) for a significant proportion of green innovations filed between 1970 and 2010 in the following fields:

- environmental management
- water management
- climate-change mitigation technologies (CCMTs) for energy production
- greenhouse gas capture and storage
- CCMTs for transportation
- CCMTs for buildings
- CCMTs for waste-water and waste management
- CCMTs in the manufacturing industry

We assign patent applications to nations using the inventor's address information in PATSTAT to assess national knowledge bases. This method produces a weighted matrix W(y), each member of which Wc,t(y) reflects the fractional count of innovations ascribed to nation c and technology t in year y.

1.1.2 Approach to Green Technology

We concentrate on the green sector-fitness of nations that host inventors of green technologies, as well as the complexity of the green technology classes contained in the innovations.

Remember that the peculiarity of sector-fitness is that we do not extract information from the entire technology spectrum (all possible IPC and/or CPC classes) to compute it; rather, we limit ourselves to a subset of classes that identify the relevant area for the study of a particular sector of activity, in our case, green technologies. Furthermore, keep in mind that this method has been effectively used to break down the fitness profile into specific sectors in the analysis of nation exports.

Applying sector-fitness to technology does, without a doubt, carry certain dangers. The primary problem is that interpreting sector fitness for technologies may not be as simple as it is for industries.

In reality, establishing an industrial sector from a collection of goods entails combining things that are categorically and broadly allocated to just one sector. The same cannot be true for technologies, since several technical fields, i.e. the objects that we use to describe the technological equivalent of a sector, typically contribute to the same patent, and these fields are usually very far apart within the classification tree. As a result, studying green technology courses in isolation overlooks a plethora of non-green subjects that are, nevertheless, essential to green innovations. With these limitations in mind, we anticipate that the data selection used in applying the sector fitness method to researching green technology will still provide acceptable findings. For a more thorough explanation, the interested reader can turn to Appendix B.

The EFC method is used in the computations, and the inputs are binary matrices of nations (rows) and classifications (columns). The fundamental assumption is that each patent family is assigned a single unit that is shared across (country, class) pairings. Because patent applications can be traced back to their filing year, it makes sense to create a series of annual weighted matrices W(y), where each matrix element Wc, t(y) is the sum of the shares of patent applications filed in year y that can be traced back to nation.

1.2 Country and Technology Rankings for Green Fitness:

Green fitness rankings across all four time periods. The more complex a country's portfolio of green technology is, and therefore the more sophisticated its innovation capabilities are, the higher the rating. We provide a synthetic sketch that focuses on how nations' innovation capability develops over time, using color coding to differentiate three groups based on starting rankings: leaders (black), followers (purple), and laggards (yellow) (orange). To begin with, the majority of the nations that ranked first in 1980 still do so in 2010. Despite this, we see considerable variation in their long-term trajectories. A first group of global leaders, such as the United States (USA), France (FRA), and Germany (DEU), maintained a consistent high ranking throughout the period, while others, such as Japan (JPN), Sweden (SWE), and India (IND), remained mostly in the upper echelons, but also declined slightly and were overtaken in the rankings by some follower and laggard countries. Among them, Malaysia (MYS), South Korea (KOR), China (CHN), Slovakia (SVK), Portugal (PRT), and Saudi Arabia (SA) are some of the fastest-growing nations, as measured by increases in the green fitness rating (SAU). They all began in the mid-to-low ranks in 1980 and have since risen to the top of the rankings following a remarkable, and consistent, ascent. It is worth noting that the geographical distribution of inventive activity spreads out over time, primarily towards Asia, with Latin American and African countries having only a minor presence. In terms of Europe, the distinction between leaders and followers corresponds to the differences between core and periphery countries. It is also worth noting that laggard countries have similar stability to leaders, implying that countries that joined such groups in the 1980s tend to stay in the same group throughout, with a few notable exceptions.

2. DISCUSSION

The author has discussed about the green technology fitness, to be clear, global warming is a serious phenomenon with unique local manifestations, which means that geographic areas differ significantly in terms of their sensitivity to climatic events and their ability to respond effectively to them. Despite the fact that environmentally friendly technology is mostly developed in developed countries, the demand to decrease GHG emissions is higher in developing economies. In addition, we utilized the Economic Wellness (EFC) approach to assess their development and geographical dispersion across countries between 1970 and 2010. This allows us to divide countries into three groups: leaders, laggards, and catch-ups. While there is a clear link between GDP per capita and innovation ability, we also record the amazing rise of East Asian nations from the margins to become major participants.

3. CONCLUSION

This study examines green innovation patterns across nations and technical sectors over a forty-year period using an Economic Fitness-Complexity methodology. The most important issues the author have addressed are: which nations are the most innovative? What are the most difficult green technology to implement? What is the connection between economic growth and environmental technology specialization? The author make three significant additions to the literature. First, we use geo-localization of patent data to give an overview of the geographical and temporal features of green innovation. Second, we go beyond aggregate trends to examine each country's relative success in respect to the technology's complexity. This enables us to classify nations into three categories: leaders, followers, and laggards. The connection between GDP per capita and innovation capability is, as anticipated, direct. However, we are seeing an increase in the importance of nations that began from the bottom and have progressed to become major players. The majority of these companies are located in East Asia. Third, we add to prior green technology research by gaining a better knowledge of how innovation potential is dispersed among specializations.

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