The Sustainable (Eco) innovation Output in the OECD area: Analysis Based on Patent Data at the Country Level

Maria MARKATOU

Paper outline

This paper studies and measures the output of sustainable (eco) innovation in the OECD area. Results are based on patent records and their use as indicators of innovation output. Two points have to be noted: First, it is of particular importance, when examining the innovation output of a broad area, which comprises of many and different countries, to identify main trends, highlight major innovation fields, locate fields of dynamism and indicate fields for further development and specialization. Second, the reference to the historical evolution or long-term perspective is necessary or even inevitable for such an analysis. Therefore, this paper examines patents extracted by the OECD patent database for the total of OECD countries to study the innovation output in the sustainable (eco) area, aiming at providing a deep understanding of the existing situation and an objective statistical reference for future research in this field.

Innovation has become a very important factor to corporate success, technological leadership and economic development, both at regional and national level (Buswell, 1987; Malecki, 1991). Schumpeter (1943), with his “gales of creative destruction”, gave a vivid description of the effects of the introduction and diffusion of major technological discoveries and inventions in industry and the world economy and Romer (1994) emphasized the role of innovation. As a production factor innovation affects growth and contributes to the development of nations. According to Porter (1991), innovation, whether it relates to processes, products or organizations, determines the competitiveness of a nation, which depends ultimately on the companies’ ability to innovate and improve. The term eco-innovation is fairly recent. Eco-innovation is the development of products and processes that contribute to sustainable development, applying the commercial application of knowledge to elicit direct or indirect ecological improvements. This includes a range of related ideas, from environmentally friendly technological advances to socially acceptable innovative paths towards sustainability. In this context, the concept of eco-innovation has been created and introduced to describe the development that satisfies the needs of today without risking the capacity of the future generations to satisfy their own needs.

Since the pioneering study on the nature of innovation in the 1970s, (Gibbons & Johnston 1974; Freeman 1974), many research works have been presented regarding innovation analysis. Innovation is the output of innovation process. Innovation process is considered to be a highly systemic and complex process, which varies across industry, technology and firm size. Particularly for firms, firms develop innovations responding to their particular markets.

1 National and Kapodistrian University of Athens, University of Thessaly- Unit for Innovation and Entrepreneurship Home address: 9 paleologou street, Larissa 41223, Greece
and technological challenges. All these factors make innovation difficult to be measured in complete and standardized ways. However, given the importance of innovation for national and firm wealth and welfare, the issue of measurement has become even more demanding. Nowadays, the literature on measurement of innovation is abundant, every day being improved and increased, and focused on measuring innovation at both firm, sector, regional and national level, as well as in combination to other economic and managerial parameters. The main methodological conclusion that can be derived from the study of literature is that innovation can be measured only through its products and only indirectly, with the contribution of relative indicators. One very important category of such indicators is patent indicators.

The existing bibliography has proposed several indicators for the description and measurement of technological innovation have been proposed. The most common of them are the indicators that derive from R&D, patents and new products (Basberg 1987; Pavitt 1988; Griliches 1990; Archibugi 1992). This study uses patent data as a proxy and measurement indicator to elucidate technological innovation in Greece, taking advantage of their positives and also considering their negatives. An invention can be eligible for a patent, only if the innovation that this invention 'hides' is novel, involves a non-obvious inventive step, and could be commercially viable (Dernis and Guellec 2003; Dernis and Kahn 2004). Among the advantages of using patent data at the study of technological innovation are first their easy accessibility, high reliability and precise definition (Ernst 1998; 2001). Second patent data are accurately recorded and easily elaborated, while they can be used to examine and study different levels and kinds of analysis (e.g. technological, sectoral-industrial, national) (Griliches 1990). Third, patent data are rather 'objective' indicators, as patent documents are examined and eventually granted by a single national patent office. Finally, in comparison with or in contrast to other sources, patents are often the only timely measure of rapid technological change, particularly in the context of global competition. However, as every tool of analysis, patent data exhibit also limitations. First, every patent office treats patents equally, while they are not and nor do all patents exert the same economic impact and the same technological and economic value (Jaffe et al. 1998; Gay et al. 2005; Wang 2007; Lee 2009). Second the propensity to patent differs across countries, sectors and firms and this difference overestimates or underestimates the results in terms of performance (Arundel and Kabla 1998; Makinen 2007). Meanwhile this difference is due in part to the level of protection afforded by the patent, but also to the possibility of protecting monopoly rights by other means depending upon market conditions. Third, there are differences in patent regimes across countries and this means that it is difficult to be certain that one is comparing 'like with like'. For instance, some countries would require multiple patents for the same innovation which could be covered by a single patent in other countries.

The data for this study is based on the OECD patent database (OECD 2012). The main issue with this kind of data and in relation to the research aim of the paper is the method in use for the identification of sustainable (eco) patents. Two methods have been used so far. The first method is based on the examination of all codes classified to each patent according to the international technology classification (IPC) and in relation to sustainable (eco) matters. Thus, the first method focuses on the technological content of each patent as derived from its assignment to one or more patent codes and its interpretation. The second method relies on the 'creation' of keywords which should be also closely related to sustainable (eco) matters. Thus, the second method scans every patent in a dual way, both its short description and the interpretation of the technological content of each patent searching for these keywords.
Therefore, it could be argued that results depend on what and how the term sustainable (eco) is defined. Obviously, the use of patents documents to measure sustainable (eco) innovation could raise strong methodological issues. Their identification implies time and data consuming methodologies based on IPC classifications and on relevant keywords. The OECD patent database classifies sustainable (eco) patents in the following fields: a) renewable or alternative energy and resources (solar, hydro, wind, geothermic), b) technologies related to vehicles (e.g., electrical and hybrid vehicles), c) energy technologies related to house-domicommercial and industrial sectors (e.g. insulation, heating, lighting, cement industry), d) Recycling (e.g. reusing waste), e) elaboration of waste and their disposal (e.g. radioactive, solid, waste water, waste’ incineration), f) technologies related to pollution (e.g. air, industrial, vehicle, water cleaning technologies), g) technologies that protect from the noise, h) Cultivations and general activities of the agricultural sector, j) rest technologies in relation to monitoring equipment and other applications.

The paper is structured as follows: **Section one** is the introductory part of the paper, where the theoretical and empirical framework of innovation in relation to competitiveness, development and growth is discussed. **Section two** comprises of three parts: The first part defines the term sustainable (eco) innovation; the second provides arguments for and against the use of patent data for the measurement of sustainable (eco) innovation output, ending up to the conclusion that patent data may be considered and accepted to be good and reliable indicators of innovation output. The third part of section two is devoted to a bibliography review concerning the measurement of sustainable (eco) innovation through patent data. **Section three** describes the data that has been used and the methodology that has been followed for this study. The data is based on patent data extracted by the OECD patent database at country level, while the main part of the methodology relies on defining the sustainable (eco) patent and searching for it, focusing on the relevant patent codes. **Section four** describes the research results, which are presented at **two levels**: The overall OECD pattern of the production of sustainable (eco) innovation output is presented at the first level, both totally (whole period of analysis) and comparatively (comparison of performance between the two sub-periods). The best and worst country performers are identified at the second level, as well as indicators of ‘relative innovation advantage’ at country level. **Section five** synthesizes and further discusses the results also tracing for changes in trends and behaviour in both the introduction or withdraw of sustainable (eco) kinds of innovation and their relative importance. The paper also provides evidence of the high or low concentration of the developed innovation output inside relative technological and industrial sectors. Finally, section six presents the main conclusions of the paper.

**Keywords:** Eco- innovation, Greece, Innovation output, Measurement, Patents

**References**


[9] C. Freeman, The Economics of Industrial Innovation, London: Pinter, 1974