



Economic development evaluation based on science and patents



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HIGHLIGHTS

- The estimation of the economic development based on science factors.
- Economic growth prediction based on science and technology.
- The accuracy of the extreme learning machine (ELM).

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ABSTRACT

Economic development could be achieved through many factors. Science and technology factors could influence economic development drastically. Therefore the main aim in this study was to apply computational intelligence methodology, artificial neural network approach, for economic development estimation based on different science and technology factors. Since economic analyzing could be very challenging task because of high nonlinearity, in this study was applied computational intelligence methodology, artificial neural network approach, to estimate the economic development based on different science and technology factors. As economic development measure, gross domestic product (GDP) was used. As the science and technology factors, patents in different field were used. It was found that the patents in electrical engineering field have the highest influence on the economic development or the GDP.

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1. Introduction

Economic development is very important for sustainable growth of any society. Different factors could have different impact on the economic development. Gross domestic product (GDP) could be considered as the main measure of the economic progress and development. Science and technology factors could be the most important for the economic progress due to very rapid technological development. There is need to investigate relationship between science and technology factors and economic development. So far there were several attempts to correlate the technology and economic growth.

For example, in article [1], authors studied the trend in the development of research in economics and management within the application of natural science and engineering methods. It was found that the most widely used natural science and engineering methods, when solving researching and applied tasks, are related to the following groups: econophysics,

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thermodynamics, informational value theory, economic genetics, cenoses theory methods and also methods based on chemical kinetics and stoichiometry approaches. The results in study [2] were shown that the research and development efficiency is substantially higher than the socio-economic efficiency. Among the dual-use technology development programs, material and chemical engineering programs demonstrate relatively higher performance. Social technologies could play into the equation of economic development and empowerment for women according to results in article [3]. Authors of article [4] was suggested that there are different indices to track progress in technology-based economic development. It was found close relationship between science & technology inputs and economic growth in article [5]. In paper [6] an attempt was made to analyze the science & technology manpower employment in relation to economic development based on quantitative analysis. Technology managers, scientists, and engineers could provide environmentally sound, innovative solutions to complex industry problems improving economic development [7]. As national boundaries become notional, and as the concept of global citizenship gets evolved, there is no doubt that the rapid advance of science and technology will directly fuel many of these [8]. Technology development control may be accelerated by increased investment [9]. The aim of paper [10] was to foster a deeper appreciation of the economic importance of science and technology issues. The role of income distribution and technology transfer in the process of economic development was studied also in article [11]. The enhanced innovation capacity of China and India is primarily due to their heavy investment in the inputs of innovation system [12]. The quest for sustainable development is seen as an intrinsic part of the reconstitution of environmentally-oriented science and technology policy that has been taking place over the past 15 years in most European countries [13]. Emerging generic technologies seem set to make a revolutionary impact on the economy and society. However, success in developing such technologies depends upon advances in science based on the article [14]. Globalization has had a profound impact on development, enabling countries that could exploit its propelling forces to pursue a potent strategy of export-led economic and technological development [15]. Well-articulated information and communications infrastructures could generate a direct impact on domestic and global economic growth opportunities and have been shown to be an essential factor in reducing disparities between developed and developing economies [16]. There is a significant gap between the practice(s) of community-level socio-economic development and research into the adoption, use, and impacts of information technology [17].

Although there were different methods for economic growth modeling in this study the main aim was to apply computational intelligence methodology, artificial neural network approach, for economic development estimation based on different science and technology factors.

2. Materials and methodology

In the beginning, different science and technological factors were used as inputs for economic developed estimation. These inputs were acquired from World Bank database for European Union countries. Therefore all inputs were selected according to the database for science and technology. These parameters are listed as:

1. Research and development expenditure.
2. Scientific and technical journal articles.
3. Patent applications for nonresidents.
4. Patent applications for residents.
5. Trademark applications for nonresidents.
6. Trademark applications for residents.
7. Total trademark applications.
8. Researchers in research and development sector.
9. Technicians in research and development sector.
10. High-technology exports.

Furthermore the number of granted patents were analyzed by field of technology as the shown in Table 1. The aim is to select which field of technology [18] of the granted patents has the most influence on the economic development.

2.1. Artificial neural network

An artificial neural network (ANN) has three layers: input, output and hidden layer (Fig. 1). Transfer function is the main core of ANN which maps the inputs to the output. Learning rule is the main operation of the transfer function. Back-propagation (BP) and extreme learning machine (ELM) [19] were used in this study as learning algorithms. Table 2 shows the user defined parameters for the ANN model in this study.

The three statistical indicators were used for the performance evaluation of models: root-mean-square error (RMSE), Pearson correlation coefficient (r) and coefficient of determination (R^2).

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