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INTERNATIONAL TRANSFER OF ENVIRONMENTAL PROTECTION TECHNOLOGIES AND ITS CONNECTIONS WITH THE R&D SECTOR

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ABSTRACT: International transfers of the environmental protection technologies are increasingly important in the international trade and economic development.
The article' s aim is to discuss the subject and the level of international transfers in the environmental protection sector in connection with the development of the R&D sector in the chosen European countries. In the framework of selected European Union countries there were analyzed the relationships between the international transfer of eco-technologies and the research and development sector, which turned out to be positive. The methodology was based on the presenting, comparing and measuring the strength of the connection between the international transfers in environmental protection technologies and the R&D sector characteristics. The limitation of the research turned out to be the lack of the data after 2013 year and lack of the data for each European country. The practical implication of the analysis is that the support for the R&D sector can cause better environmental protection technologies exchange between countries and from the social point of view – better natural environment for the society in general.

KEYWORDS: environmental technologies, eco-technologies transfer

Introduction

International transfers of the environmental protection products, services and technologies has become an important instrument of many modern states and it is implemented within the framework of an economic development respecting the natural environment requirements. International exchange of technologies favoring the high quality of the environment takes place by means of a functioning infrastructure of the research and development sector, which consists of appropriately trained human resources, financing of the R & D projects and the previously developed technology.

The main aim of this work is to measure the relationship between the imports and exports of environmental technologies and the level of the environmental research and development sector of the selected European countries expressed by the Eco-innovation Index, calculated by EUROSTAT. The statistical data on imports and exports of environmental technology, including the expenditure of the R & D sector and the index of the Eco-Innovation were analyzed for the period 2008-2013. The export and import of eco-technologies were presented for the leading countries in the world in these areas, while in the second part of the empirical study, the data was limited to 13 European countries due to the availability of the Eco-Innovation indicator. The Eco-Innovation indicator was compared to the level of eco-technologies' international transfers. The data about the international trade of eco-technologies was derived from the report of the International Trade Centre (ITC), "Trade in Environmental Goods and Services: Opportunities and Challenge" from 2014.

An overview of literature

Technology in its essence includes information, knowledge, practical experience and the use of the equipment and processes in the production of goods and services (Working Group on Environmental Technology Transfer, 1991, p. 58). The capacity to use, modify, retain, and constantly improve information and knowledge and also to produce the goods and services more effectively depends on many factors that are both explicit (e.g., companies, equipment, and infrastructure) and implicit (e.g., education, experience, training handbooks, organization structures, or the management capacity (Wallender, 1979, p. 34).

Technology is the most important factor in the development process. Modern economies are less and less dependent on the availability of raw materials or cheap labor forces, and more and more on its ability to use new technologies and the application of them to the production methods. In turn,

the effective use of modern environmental technologies requires the support of the research and development infrastructure necessary for their international transfer.

According to the United Nations environmentally sound technologies are techniques and technologies capable of reducing environmental damage through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior the discharge, or utilize and recycle the production residues (United Nations, 1997).

According to the EUROSTAT statistics on the ecological products and services, such products and services are produced for the needs of the environment (ie. the prevention, reduction and elimination of pollution and any other degradation of the environment), as well for the resource management (ie, preservation and maintainance of the natural resources, and thus protection against their exhaustion), (Eurostat, 2015, p. 9).

The first definition includes all available solutions with the ability to counteract the negative environmental change in the eco-technologies sector and according to the nomenclature of the Eurostat environmental technology can include only those technologies that have been created solely and specifically for the needs of environmental protection.

According to the OECD classification (the estimates of the data on the volume of exports and imports in the field of environmental technology in the next chapters are presented according to this classification), the environmental sector includes the following subareas (OECD, 1999, p. 9):

- Pollution management
  - Air pollution control
  - Wastewater management
  - Waste management
  - Remediation of the environment
  - Noise and vibration abatement
  - Environmental monitoring, analysis and assessment.
- Eco-industry management
  - Clean / efficient resource, technologies and processes
  - Clean / efficient products.
- Resource management
  - Indoor air pollution control
  - Water supply
  - Recycled materials
  - Production of renewable energy
  - Heat/energy saving and management
  - Sustainable agriculture and fisheries.
  - Sustainable forestry

– Natural risk management
– Eco-tourism
– Other. (e.g. nature conservation, habitats and biodiversity).

Sustainable development has become the contemporary mantra because it supports multiple objectives, including the economic growth and environmental protection, both the desirable phenomenon. Yet the possibility of achieving such goals together is closely linked to the diffusion of environmental technologies (Wallender, 1979, p. 56).

Economic development and implementation of modern technologies are possible with the parallel concern for the environment, but it needs support for the research and development sector, which generates these technologies.

The concept of green technology which is synonymous to the concept of environmental technology is based on Agenda 21, issued on the occasion of the United Nations Conference on Environment and Development (UNCED) in 1992. The concept has been developed by the Organization of the United Nations Educational, Scientific and Cultural Organization (UNESCO), which indicated that '' without technology, there is no sustainable development''.

The leading trend in the environmental policy of many countries and regions in the frame of the sustainable development idea should integrate the economic, social and environmental issues, and this is possible primarily by the technological advances.

International technology transfer is a mechanism for stimulating innovation processes in the economy of the host foreign technology, because it stimulates stakeholders to actively implement the learning process, which is necessary to use the transferred equipment or methods (Firszt, 2007). R & D sector is applicable for both the creation of new technologies, their effective transfer and also for their implementation in the country-recipient.

The basic factors of successful technology transfer include (Stawasz, 1997, p. 96):

- the ability and willingness to cooperate with the participants of technology transfer;
- the channels of flow between the centers for the creation of new technology (universities, research centers) and the economy;
- the relationship between education and the practice;
- the effectiveness of the units of the technology transfer;
- the speed in the adoption of information and its complexity.

On the other hand, the effective measures of the achieved level of the environmental protection technologies transfer can be:

- the number of implemented innovative environmental solutions;
- the level of employment in knowledge-intensive industries as a percentage of total employment;
- the level of employment in the fast developing businesses in innovative businesses.

Innovations in technology development have a major impact on the creation of favorable conditions for the continuous generation of research and development (Hultman).

In contrast, the generated conditions for research and development are conducive to the development of new environment-friendly industrial solutions. They are two (R & D sector and the transfer of environmental technology) each co-influencing mechanisms.

OECD and UNEP emphasize the significant role of stimulating the sustainable development of the industry to improve the levels of dissemination and the use of the environmental technologies (Carrillo-Hermosilla et al., 2009). There should also be emphasized the role of international trade in these processes.

In addition, supporting the trade of the environmental technologies has the feature of increasing the general prosperity of the public through the dissemination of environmentally friendly solutions, which improve the conditions of the environment.

Many countries have paid special attention to the environmental technologies in the research, development, use and export processes. Some countries specialize in the special R & D focused on environmental technologies.

The production of environmentally friendly technologies in China could be achieved through the innovation. The emphasis should be placed on adapting the green technology to the fundamental issues of production, and thereby the change of the models of achieving economic growth (Wang et al., 2013, p. 31).

The discrepancies in technology diffusion of various countries within similar income can be explained by differences in their innovative capacity. In explaining this discrepancy, Tomlinson and others and the World Bank point out that factors such as foreign direct investment (FDI), openness and ease of trade, the presence of well-functioning markets, legal and regulatory framework and the level of higher education are more important for the diffusion of technology than the income level (Technology Transfer for Green Growth in Africa, 2012, p. 117). The move towards intensification of the use of environmentally friendly technologies is connected mainly with the activity of research and development (Technology Transfer for Green Growth in Africa, 2012, p. 117).

Research methods

The aim of the research in the article is presenting the relationships between the international transfer of eco-technologies and the level of the research and development sector. International exchange of technologies favoring the high quality of the environment takes place mainly by means of a functioning infrastructure of the research and development sector.

The transfer of green technologies, which is active between the countries, both developing and highly-developed, was estimated for the export and import of such technologies. Data on the amount of these transfers were developed by the International Trade Centre (ITC) based on the classification of the environmental sector established by the OECD.

The whole distinction between eco-products and ecological services is difficult to make due to the fact that many environmental services requires certain environmental goods in the performance of its functions. Similarly, the sales of organic product usually includes the associated with it the ecological service or requires any form of sevicing related to its installation, maintenance or monitoring.

In the first part of the analysis there was presented the average level of the transfer of the environmental protection technologies in 2008-2013 years for the chosen European countires.

In the next part of the article there was realized the analysis of the relationships between the level of advancement of "green-oriented" research and development in the economies, expressed as an index of Eco-Innovation and the level of imports and exports of environmental technologies of the selected European countries (the European leading exporters and importers in terms of environmental technologies). The following analysis is limited to 13 European countries due to the fact that the level of exports and imports in the field of environmental technologies and Eco-Innovation index are available only for the European countries. For other countries, which import and export of environmental technologies was presented in first analysis of this article, EUROSTAT does not analyze the Eco-Innovation Index.

The third analysis contains the reasearching on the strength and direction of the correlation between the average levels of foreign trade in the environmental technologies in 2008-2013 and the Eco-Innovation Index of the selected European countries available for 2013 year

The last part of the research consist of the presentation of the Pearson correlation coefficients between the average variables of foreign trade of the environmental technologies for 2008-2013 time frame and the R&D sector development characteristics expressed also in the average level for 2008-2013 time frame by:

- Expenditure on research and development per capita [EUR];
- Total expenditure on research and development [mln EUR];
- Expenditure on research and development expressed [% of GDP].

Results of the research

Figure 1 shows the average export of environmental protection technologies in 2008-2013 in bill USD.

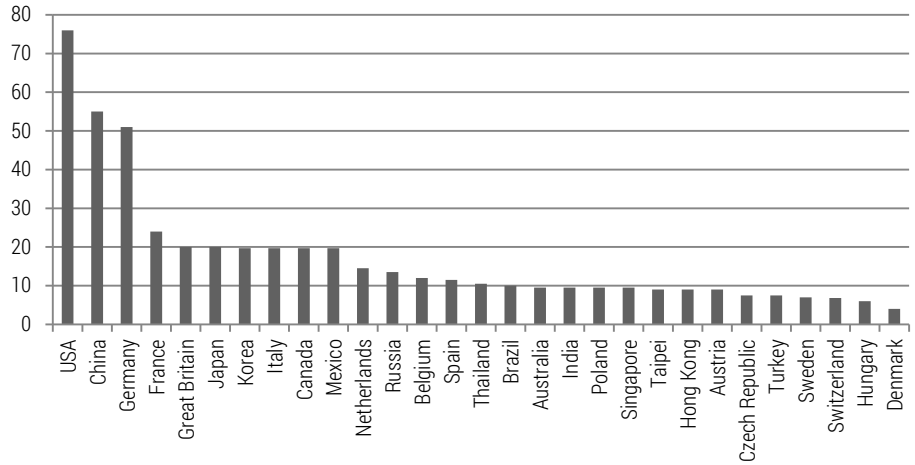

Figure 1. Shows the average export of environmental protection technologies in 2008-2013 [bill USD]

Source: Bucher, 2014; www.intracen.org [20-10-2016], (according to the OECD classification of environment al protection industry).

The leading exporters in the export of environmental technologies in 2008-2013 were Germany, China and USA. At the 23 place there was Poland, just behind Sweden, Denmark and Hungary.

Another picture, table no. 2 illustrates the leading countries in terms of import of the technologies related to the natural environment. The first three positions were taken by the US, China and Germany.

Both in terms of the exports and imports of environmental technologies, the first three positions are taken by three states with the difference that in terms of exports on the first place there was Germany and the United States were third, while in terms of imports, the situation was reversed. Second place in terms of both imports and exports of environmental technologies belonged to China.

Figure 2 shows the average import of environmental technologies in the selected countries in 2008-2013 in bill USD.

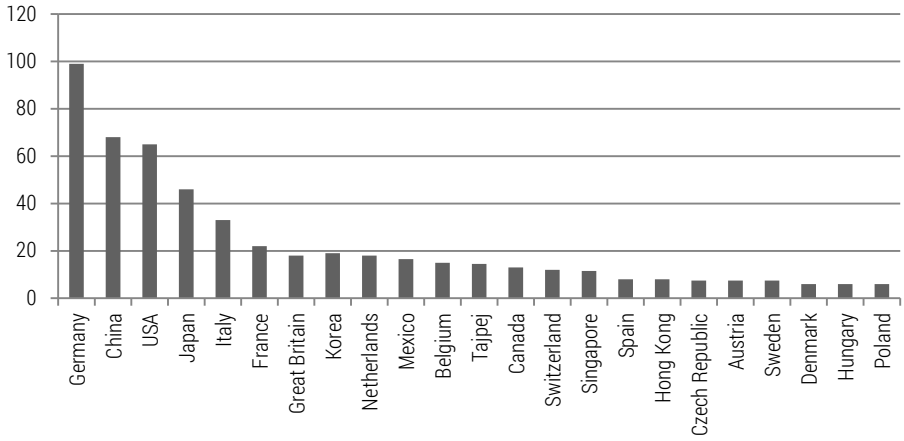

Figure 2. The average import of environmental protection technologies in 2008-2013 [bill, USD]

Source: Bucher, 2014, www.intracen.org [20-10-2016], (according to the OECD classification of environment al protection industry).

Table 1 presents the ranking of the selected European countries in terms of Eco-Innovation Index and the level of exports and imports of environmental technologies.

According to the table 1 the following results were observed among selected European countries:

- high positions (over 6 places) in terms of the index of Eco-Innovation, and the high value of the Export and Import of Eco-technologies (up to 6 places) concerned the countries such as Germany, Britain, France;
- high positions (over 6 places) in terms of the index of Eco-Innovation at a relatively low position (less than 6 places) under the terms of the Export and Import of Eco-technologies – Sweden, Denmark;
- low position (less than 6 places) in terms of the Eco-Innovation Index with a relatively high (over 6 places) potential of Export and Import of Eco-technologies – Italy, Netherlands;
- low position (less than 6 places) in terms of Eco-Innovation Index with a relatively low (less than 6 places) potential of Export and Import of Eco-technologies – Belgium, Austria, Spain, Italy, Hungary, the Czech Republic, Poland.

Table 1. The ranking of the selected European countries in terms of Eco-Innovation Index and the level of exports and imports of environmental technologies.

States	Eco-Innovation Index* 2013	Environmental Technologies Export[1]	Environmental Technologies Import
Sweden	1	10	11
Germany	2	1	1
Denmark	3	11	13
France	6	3	2
Netherlands	10	5	5
Austria	7	9	8
Belgium	8	6	6
Great Britain	4	4	4
Spain	5	7	7
Italy	9	2	3
Czech Republic	11	8	10
Hungary	12	12	12
Poland	13	13	9

* Index Eco-innovation (Eco-Innovation Scoreboard – Eco-IS) is the first tool to assess and illustrate the performance of eco-innovation in all EU Member States. The scoreboard shows various aspects of eco-innovation through the use of 16 indicators grouped in five thematic areas: Inputs of eco-innovation, Eco-Innovation activities, Products of Eco-Innovation, Efficiency of the Resource Use and Socio-Economic effects of eco-innovation. Eco-IS complements other methods of measuring innovation of the European Union and aims to promote a holistic view of economic, environmental and social performance of analysed countries. More on Eco-innovation index can be read at: http://www.eco-innovation.eu/index.php?option=com_content&view=article&id=2&Itemid=34 [18-10-2016].

Source: author's own work based on H. Bucher, J. Drake-Brockman, A. Kasterine, M. Sugathan, *Trade in Environmental Goods and Services: Opportunities and Challenges. International Trade Centre Technical Paper*, Genewa 2014, www.intracen.org [20-10-2016]; www.eco-innovation.eu [18-10-2016].

Table 2 presents the Pearson correlation between the average of foreign trade in the environmental technologies in 2008-2013 and Eco-Innovation Index of selected European countries in 2013.

According to table 2 both between the exports and imports of environmental technologies and the eco-innovation index there is moderately strong positive correlation. This shows a moderately strong positive depending on the growth in the transfer of environmental technology with a growing potential for innovative activity and management in the acquisition and implementation of new green technologies.

Table 2. The Pearson correlation between the average of foreign trade in the environmental technologies in 2008-2013 and Eco-Innovation Index of selected European countries in 2013

Foreign trade data	Eco-Innovation Index
Import of Eco-technologies	0,35
Export of Eco-technologies	0,36

Source: author's own work based on H. Bucher, J. Drake-Brockman, A. Kasterine, M. Sugathan, *Trade in Environmental Goods and Services: Opportunities and Challenges. International Trade Centre Technical Paper*, Genewa 2014, www.intracen.org [20-10-2016]; www.eco-innovation.eu [18-10-2016].

Table 3 presents the Pearson correlation coefficients between the variables of foreign trade of the environmental technologies and the R&D sector development expressed by:

- Expenditure on research and development per capita [EUR];
- Total expenditure on research and development;
- Expenditure on research and development expressed [% of GDP].

Table 3. The correlation coefficients of Pearson between the average expenditure on research and development (R & D) and the average levels of foreign trade of the environmental technologies in 2008-2013 of the selected European countries

Foreign trade	R&D Expenditures capita [EUR]	Total R&D Expenditures [EUR]	R&D Expenditures [% GDP]
Environmental Protection Technologies Import	0,55	0,95	0,19
Environmental Protection Technologies Export	0,71	0,88	0,46
Environmental Protection Technologies Export + Import / GDP			0,30

Source: author's own work based on: H. Bucher, J. Drake-Brockman, A. Kasterine, M. Sugathan, *Trade in Environmental Goods and Services: Opportunities and Challenges. International Trade Centre Technical Paper*, Genewa 2014, www.intracen.org [20-10-2016] (according to the OECD classification of environment al protection industry); www.ec.europa.eu [18-10-2016].

As shown in Table 3. we can observe very strong significant positive correlation between the total expenditures on research and development (R & D) and the level of Import and Export in the field of environmental technologies in the group of the analyzed countries. The total spending on research and development (R & D) is significantly associated with the transfer of environmental technologies.

Conclusions

International transfer of environmental technologies stays in connection with the idea of achieving sustainable development at the countries supporting it. The is observed in the improvement of the conditions for the development of eco-innovation and the transfer of modern environmental technologies. Opportunities to create the value added in the field of research and development sector through the transfer of green technologies and value added in the transfer of environmental technology by the activity of R & D sector are almost limitless and can be implemented at the level of economic sectors, between enterprises, as well as on the international market.

The leading exporters and importers of environmental technologies come from three continents – From North America – the US, from Asia – China and Europe – Germany. The analysis based on the literature concerning the transfer of environmental technologies, as well as the empirical considerations can prove that there are significant positive correlations between the activity of R & D sector and the international transfer of green technology. Among Europe's leading exporters and importers of environmental technology there are the countries that occupy significant positions in this field, while at the same time they are the leaders of eco-innovation generation. The relationship between the development of the activities at the R & D sector and the transfer of environmentally friendly technologies is marked also at the analysis of the relationship between the level of international technology transfer and the expenditures on research and development (R & D).

The international transfer of eco-technologies becomes an instrument widely recognized and used in the plans and strategies for socio-economic development.

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