



INTERNATIONALISATION CHALLENGES FOR INNOVATION DEVELOPMENT IN HIGH TECHNOLOGY SECTOR

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Abstract. High technology sector faces contemporary management challenges related with open innovation processes. Innovation dissemination is influenced by various variables, which require broad level of collaborative, creative efforts and effective internationalisation strategies for high technology companies. Main aim of the article is to discuss theoretical development in open innovation concept and internationalisation activities and to evaluate main challenges for internationalisation of innovation activities and sustainable inflow of new knowledge. In order to increase global competitiveness high technology sector actors need to understand important elements of innovation internationalisation process and adopt effective practice.

Keywords: high technology sector, internationalisation, global R&D, open innovation, key enabling technologies, knowledge transfer, innovation processes.

JEL Classification: M11, M10, M20.

Introduction

High technology sector is considered to be one of the important drivers of economic and employment growth in industrialised and developed countries. Globalisation of internationalisation activities and democratisation of research activities influences high technology sector developments. In European Union countries, high technology sector activities are considered to be crucial to achieve the desired structural transformation of economies (European Commission 2008). Development of innovations at global level is mainly related with high technology sector. Classification of high technology sector is multidimensional and often is based on the regional contexts. In practical and theoretical studies OECD classification, which is focused towards industry (sectorial approach) and produced goods (product approach) (Hatzichronoglou 1997) is used. This classification includes direct and indirect scientific research and technological development, but other factors like scientific personnel, intellectual property of technology, licenses and know how, strategic technological partnership among companies.

Internationalisation processes drive high technology sector, which amplifies open innovation context. Internationalisation activities can be oriented towards inward and outward directions. In 2010 European Commission implemented new sectorial study, with revised evaluation (Loschky 2010). Evaluation is based on scientific research and development intensity, which could be described as ratio between investment into R&D, production output and value added. Also it is very important to understand internationalisation level of R&D activities. Competitive advantage based on product and process innovations is crucial for success of technology based companies. Foreign investments in R&D could create options for companies to develop new products. Main aim of this article is to overview main challenges regarding internationalisation of innovation activities.

Theoretical frameworks for innovation internationalisation

The internationalisation of technology is very important factor, which describes modern globalisation processes. High technology exchange between countries have grown and cross-border relationships between countries have expanded in many ways. International co-operation in science, technology and innovation is on the rise, which could be reflected in various indicators, including patents, co-authorship of scientific publications and formal co-operation

arrangements, Flows of human capital also contribute to the internationalisation of technology through increased international mobility and rising numbers of foreign students and researchers in countries. Those elements highly influence total high technology output and value creations.

New paradigm of open innovation activities plays important role for internationalisation of high technology sector. Open innovation points towards effective transfer of knowledge and technologies to both directions (inward and outward). Open innovation processes combine internal and external ideas into architectures and systems (Chesbrough, Crowther 2006). Main studies on open innovation are focused on externalization of R&D activities Open innovation can be categorized by using company perspective (Enkel *et al.* 2009):

(1) The outside-in process: enriching the companies own knowledge base through the integration of suppliers, customers and external knowledge sourcing. The ability to access knowledge, technology, and information through relationships with other firms facilitates open innovation, which helps the firm effectively implement it (Sisodiya *et al.* 2013).

(2) The inside-out process, which refers to earning profits by bringing ideas to market, selling IP, and multiplying technology by transferring ideas to the outside environment (Lichtenthaler 2009). Inside out process and results generally are characterised as high tech sector descriptive criteria or output measurements (Glasson *et al.* 2006). In the context of this article detailed analysis of innovation activity external output is not considered for detailed analysis

(3) The coupled process refers to co-creation with complementary partners through alliances, cooperation, and joint ventures during which give and take are crucial for success. This process can be described as knowledge co-creation. Selection of strategic alliance partners requires multiple criteria evaluation: characteristics of partner, degree of fitness, intangible, marketing knowledge capabilities, complementary capabilities (Wu *et al.* 2009). Open innovation stresses the abundant landscape of external knowledge outside firms waiting to be captured by them and converted into profitable innovating products and services (Chesbrough 2003). Open innovation performance is even greater in information rich contexts (Sisodiya *et al.* 2013). It is very important for companies to create information and knowledge surrounding by including various actors (scientific, industrial, and multidisciplinary) in network. Open innovation creates platforms for extensive collaborative research activities.

The initial open innovation concept was vague and lacked concrete adoption frameworks for business context, especially in high technology sector. The new findings and theoretical analysis fill this gap (Eelko, Huizingh 2011; Dahlande, Gann 2010).

The open innovation idea is based on the new evolutionary business model, which encompasses opening of company innovation process to the external environment actors. In other words it discusses purposive inflows and outflows of the knowledge to accelerate the internal innovations, and to expand the markets for the external use of the innovation (Chesbrough 2011). This broad description of open innovation points towards effective transfer of knowledge to both directions (inward and outward). Open innovation processes combine internal and external ideas into architectures and systems (Chesbrough 2003). Main studies on open innovation are focused on externalization of R&D activities (Enkel *et al.* 2009).

Outbound open innovation refers to the outward technology transfer, and it suggests that firms can look for the external organizations with business models that are suited to commercialize the technology for outside organisations (Chesbrough, Crowther 2006). Outbound open innovation points to actively pursuing external technology exploitation, which refers to the commercialization of technological knowledge using licensing and other transfer means (Lichtenthaler, Ernst 2006). Open innovation concept is mostly used for enhancing of the R&D input and output inside the company. Internationalisation activities of high technology sector are underpinned with above mentioned open innovation paradigm. Internationalisation processes for high technology sector encompasses holistic view (Spence, Crick 2006). Initial catalysts for pursuing and maintaining an international strategy plus the subsequent triggers for international development could be classified into three categories: (1) existence and utilisation of existing contacts; this supports the networking view, (2) utilisation of resources, defined in a general sense to include financial and managerial resources (experience), enabling firms to become prepared for international development, e.g. targeting growth markets, supporting the resource based view of the firm (3) Reaction to environmental, including serendipitous, events that is consistent with the contingency view (Spence, Crick 2006).

R&D intensity, e.g. investment level into scientific research is fundamental decision for technological strategy. Competitive advantage based on product and process innovations is crucial for success of technology based companies. Investments in R&D could create barriers for existing companies through patents and enable new companies to overcome it by using of innovative technologies.

R&D investment increases absorptive capacity, i.e., the capacity to absorb knowledge created from the relationships formed with agents outside the firm, as well as the capacity to use that knowledge to increase firm performance The greater strategic and organisational flexibility of companies, associated with the possibility of diversifying activities as a consequence of R&D investment, may encourage high-tech companies to form strategic cooperation networks with other firms and scientific institutions (Nunes *et al.* 2012).

Fast development of the new ICT technologies influences internationalisation processes (Sedoglavich 2012). Author demonstrates that firms tend to be influenced by the entry decisions made by other firms in the same/similar industry targeting the same market; and that a firm's technological capabilities and the advantages of specialized knowledge act as the constraints in the development of the firm's future international strategy.

High technology sector internationalization influenced by multidimensional process, focused on outward and inward directions. For high technology companies these companies internationalization important as multidimensional process, by building cross-boundaries and knowledge augmenting process (Rodriguez, Nieto 2012). Innovation processes are driven and influenced by the exploration and exploitation of new knowledge, which is embedded in different locations and may rely on different social and inter-organizational ties scattered across the globe (Onetti *et al.* 2012)

High technology sector plays important role in contemporary global economy. Global economical crisis demonstrated that high technology sector is most immune element in economical system. Focused and effective high technology sector development is main priority for the development of advanced economies. High technology sector is strongly interconnected with internationalization and innovation activities. Contemporary theoretical frameworks lacks holistic understanding, based on rapid changes in open collaboration platforms. Complex understanding of contemporary high technology sector activities requires broad approaches, combining creativity, innovation and internationalization contexts, which allows focused development of high technology sector. Systemic technology management processes and new open innovation challenges in high technology sector are main priorities in regional and national levels. Open innovation paradigm, which influences formation of the global research and development value networks, plays important role in the development of high technology sector (Chesbrough 2003). Firstly this impact is realised through significantly increased realisation of scientific potential and transnational dissemination of research results.

Three dimensions (internationalization of activities, local vs. global) if the open relationships with outside organisations and focused activities influence the development of high technology companies. These three areas of the strategic decision making (locus, modus and focus) are required to be integrated into a systemic approach of the management, which reflects the above-mentioned holistic nature of the growth processes for technology-based firms, where innovation and internationalization are deeply interconnected (Onetti *et al.* 2012).

Internationalisation process can be oriented towards activities focused on product sales and export in international markets or extensive R&D activities based on effective research infrastructure and support (Dachs, Pyka 2010). Scientific excellence of the host country can be a major determinant for cross-border innovation activity. There is positive relation between the scientific capabilities of the host country and the number of patent applications due to the 'asset-augmenting' motive. A general proxy for the scientific and technological capabilities of the host country is its overall R&D intensity, measured by the share of aggregate R&D expenditures on GDP (Dachs, Pyka 2010). It is important to understand that intensive international research activities can connect input and output activities and enhance organisational knowledge and lead to international patent activities.

Evaluation of technological innovations is measured by many indicators, which describe potential factors important for successful development of the sector.

Global research and development developments and impact on high technology sector

One of the main indicators related with high technology spending is investment in research and development, which indicates inflow in innovation development creates new value as main output indicators. Global investments in research and development is steady and is 2,2 % of GDP (2012).

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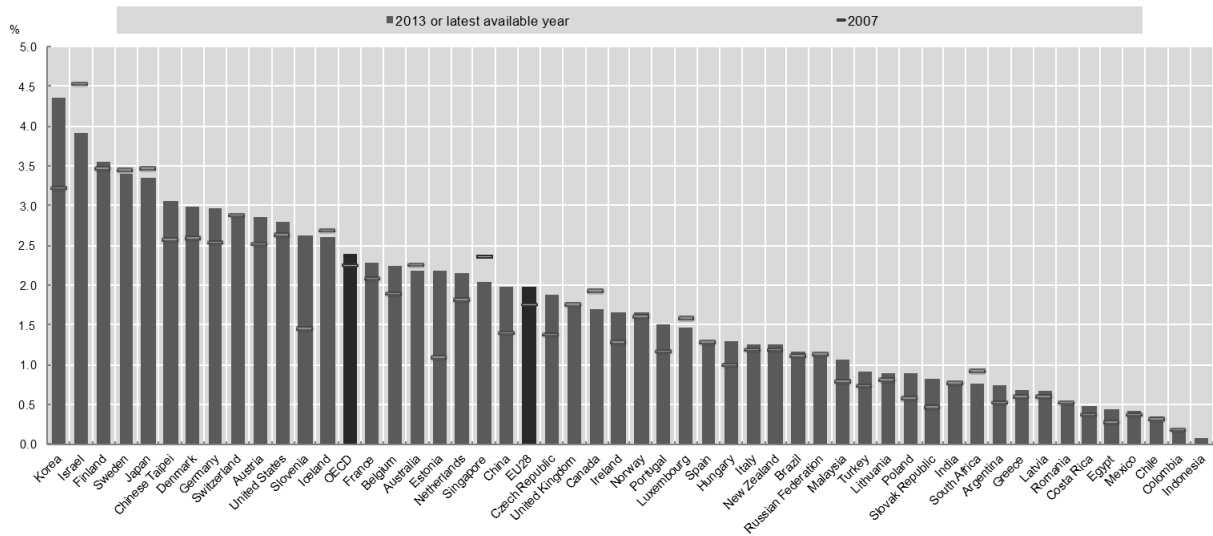


Fig. 1. Gross R&D expenditure 2013 and 2007 (Source: OECD 2014)

Global investment level clearly indicates global regional leaders in innovation and new technology developments and creates strong international hubs for knowledge accumulation and exchange. The acceleration of scientific discovery and technological development is more visible in modern society. Access to global information, inventions and innovations is faster, cheaper and better, information technologies. Changes in R&D investments by large companies indicates clear technological development in the future. Clear directions seen in high technology acceleration (see Fig. 2).

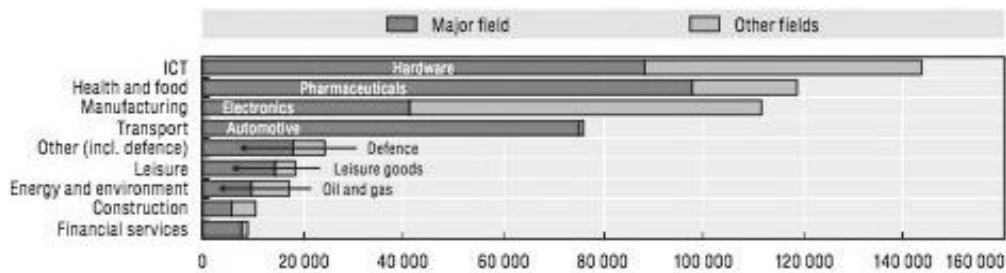


Fig. 2. Major fields of R&D investment by the world's largest corporate investors, million current EUR (Source: OECD 2014)

Important factor for R&D industrialisation is investments from abroad, which indicates internationalisation level and competitive advantage, regarding innovation development. It is important to analyse correlation between scientists level and investment level in R&D (see Fig. 3) Strong research facilities creates more opportunities for investors, also it attracts more international partners, willing to use global knowledge.

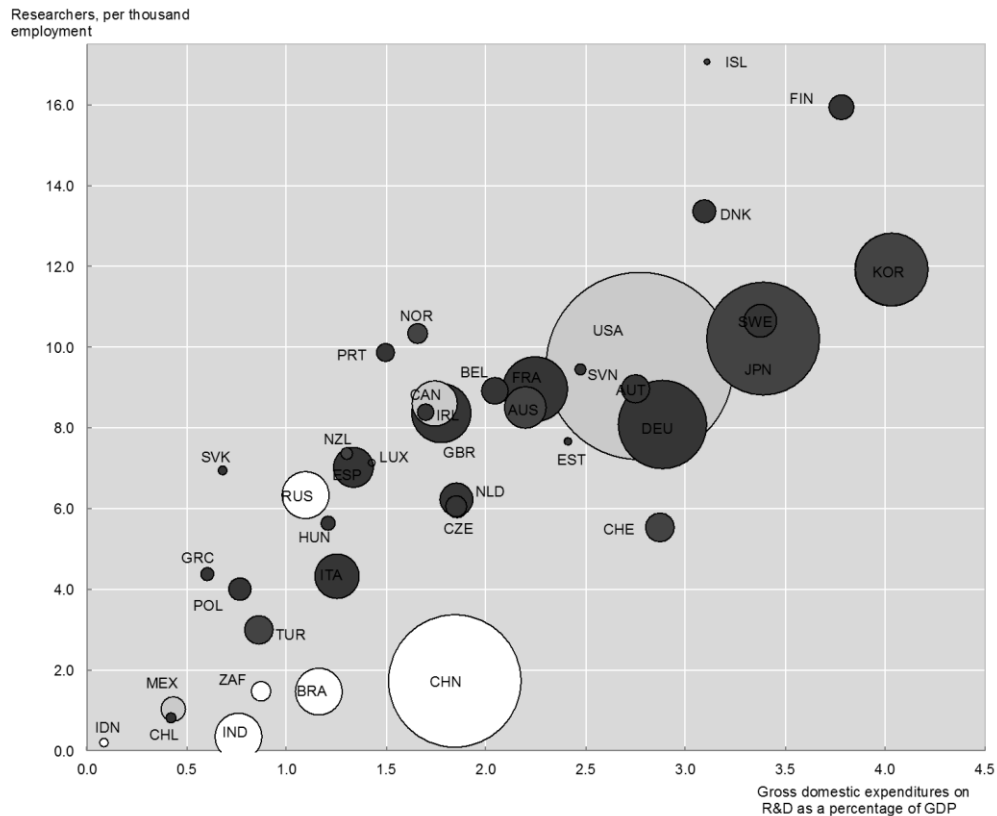


Fig. 3. R&D in OECD and key partner countries (Source: OECD 2013)

Abilities to attract foreign R&D investment sources is important factor in high technology sector development and related with talent and scientific infrastructure. Also it is important to stress that most of the investments are implemented by multinational corporations.

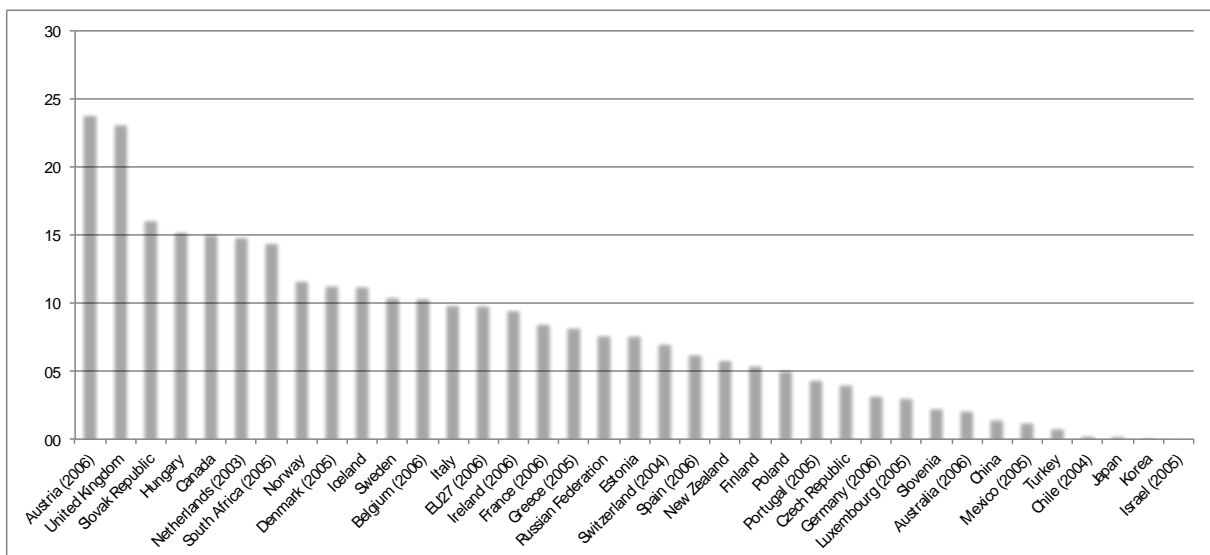


Fig. 4. Funds from abroad as a percentage of business enterprise R&D, 2007 (Source: OECD 2014)

Industrial R&D investment by the world's 2 000 largest investors remains concentrated in a few sectors, with pharmaceuticals and biotechnology, technology hardware and equipment, and automobiles and parts accounting for half of total R&D investment. Companies from three out of the top five sectors by level of R&D investment increased R&D above the world average of 6.2%, namely Software & Computer Services (11.7%), Automobiles & Parts (8.9%)

and Technology Hardware & Equipment (8.8%). The top R&D investing sector, Pharmaceuticals and Biotechnology achieved a more modest 4.1% increase of R&D. Other sectors that showed high R&D growth were the Industrial Engineering (9.8%) and Health Care Equipment & Services (8.3%) sectors (European commission 2013).

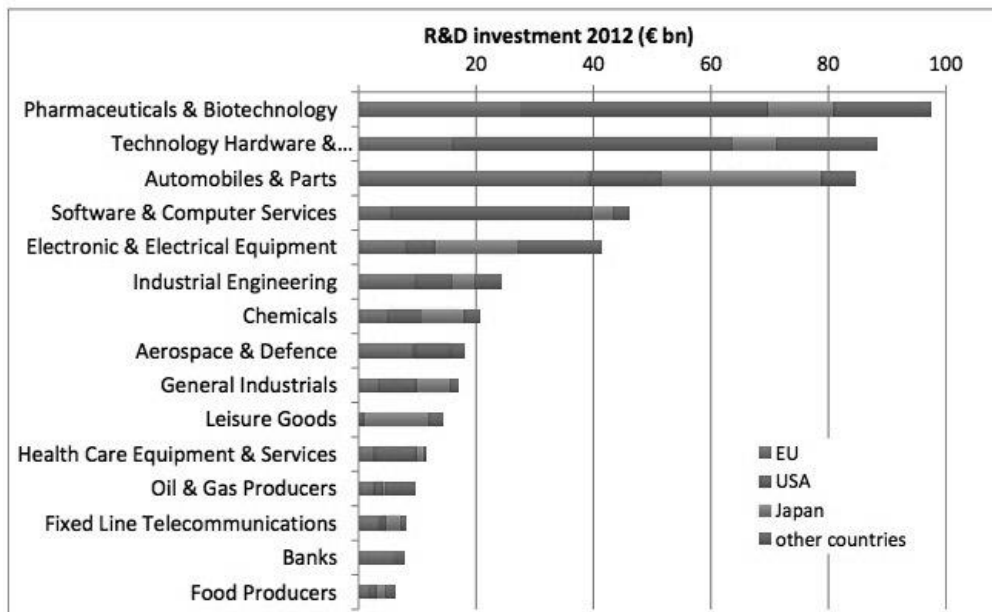


Fig. 5. R&D ranking of industrial sectors and share of main world regions for the world's top 2000 companies (Source: European Commission 2013)

International investment distribution pattern shows competitive regions. Those regions have strongest regions actively participates in corporate research and development (see Fig. 6).

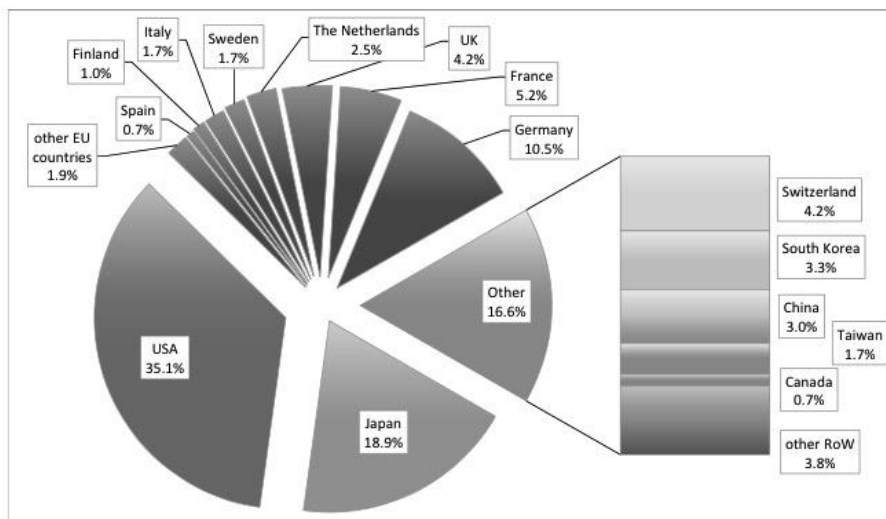


Fig 6. 2000 biggest global corporate investors in R&D (Source: European commission 2013)

Corporate investments are dominated by US and Europe regions. Competitiveness challenges requires new measures and policies from regional perspective. European initiative by promoting Key Enabling Technologies is very important. KETs are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly-skilled employment. They enable process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration.

Lithuanian strongest key enabling technology is advanced material and photonic sectors (Fig. 7). Other sectors are weak, specifically in intellectual property area.

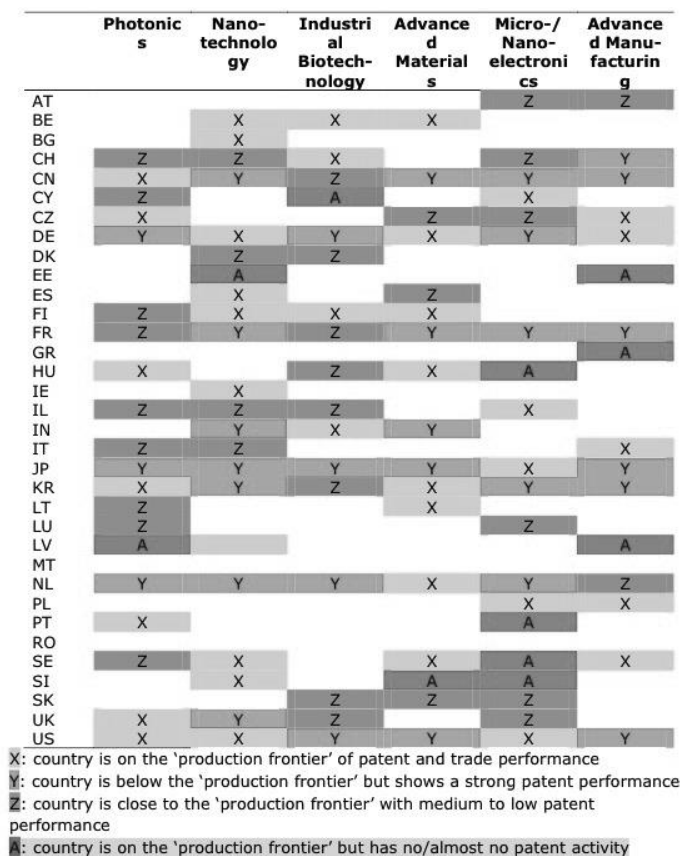


Fig 7. Overview of performance profile per country and KET (Source: Larsen *et al.* 2011)

Main innovation challenge for Europe in KET is to overcome the various barriers to commercial deployment of R&D base, the “Valley of Death” by linking together the various parts of the value-chain using for instance technology transfer mechanisms, supporting demonstration projects, and creating favourable market conditions for innovative (yet often relatively expensive) products (Larsen *et al.* 2012). This gap between basic knowledge generation and its subsequent commercialisation into goods and services could be bridge by innovative public support services and mechanisms.

The definition of the main characteristics of high-tech firms could include activity, human and technological parameters (Glasson *et al.* 2006): involvement in innovative activity, R&D intensity, R&D employment, qualified personnel, intensive use of technologies, intellectual property.

Many high-tech firms are relatively new high growth businesses, but they can also include more established businesses in mature sectors, and indeed such firms appear to account for a disproportionate share of high-tech employment. Those characteristics are very important for knowledge management inside those companies. High technology sector export, has average value in EU about 16 % of all export (table 1). It shows strong sector influence on country economic development.

Table 1. High-tech exports of high technology products as share of total exports (Source: Eurostat 2013)

	2007	2008	2009	2010	2011	2012	2013	2014
EU (28)	16,1	15,4	17,1	16,1	15,4	15,7	15,3	15,6
Estonia	7,8	7,5	6,9	10,4	14,8	14,1	15,0	16,3
Latvia	4,6	4,6	5,3	4,8	6,7	6,4	8,0	9,2
Lithuania	7,3	6,5	5,8	6,0	5,6	5,8	5,8	6,4

High technology sector dominates global patent market with international and high-level research results. Patent documents are widely used as indicators of R&D activities at the level of industries and individual firms because of certain advantages over other types of data (Smith 2005). Patents are useful for studies of the internationalisation of innovation: since a patent protects both the owner’s and the inventor’s rights, it contains information on the location

of the applicant (owner) and on the inventor's place of residence (Dachs, Pyka 2010) and cross-border patents, which can be used as an indicator for the internationalisation of R&D activities.

Conclusions and further research directions

In this article internationalisation aspects of R&D and high technology sector development issues in the context of open innovation were discussed. The open innovation idea is based on the new evolutionary business model, which encompasses opening of company innovation process to the external environment actors. In other words it discusses purposive inflows and outflows of the knowledge to accelerate the internal innovations, and to expand the markets for the external use of the innovation (Chesbrough 2011). This broad description of open innovation points towards effective transfer of knowledge to both directions (inward and outward). Open innovation processes combine internal and external ideas into architectures and systems (Chesbrough 2006). Main studies on open innovation are focused on externalization of R&D activities (Enkel *et al.* 2009). It creates broad global networking possibilities for the development of new innovative high technology products. Analysis shows that main indicators, which describe knowledge intensive technological sectors are related with knowledge transfer issues, specifically by knowledge creation (reflected in R&D activities) and knowledge share, R&D commercialisation. Analysis shows clear formation of strong global regional research blocks, which attracts investment for R&D. Those regional knowledge clusters are related with successful science policy and strong researchers' base (Scandinavian countries). Multinational corporations create huge value, with their research and development activities. High technology sector is strongly related with international business environment with export activities, which creates value for country economic development. It is important to focus on human factor development as main factor for creation of science and technology research hubs. In this context creativity factors and talent development factors could be strong influencers on high technology sector internationalisation. Analysis of internationalisation theories shows strong intersection of innovation and internationalisation activities, mostly visible in intellectual property format. Also it is important to understand that patents as output indicators refuel high technology system with new knowledge and creates constant innovation inflow. This indicates the importance of analysis for cross border inventive activities in high technology sector. Inward and outward patent collaboration indicators could be used in further evaluation models, based on multi-criteria evaluation, including research input indicators.

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AUKŠTŪJŲ TECHNOLOGIJŲ SEKTORIAUS INTERNACIONALIZACIJOS IŠŠŪKIAI PLĖTOJANT INOVACIJAS

Eigirdas ŽEMAITIS

Santrauka

Aukštųjų technologijų sektoriaus plėtra internacionalizavimo ir atvirų inovacijų sąlygomis yra aktuali vadybinė problema, kurios sprendimai reikalauja naujo, inovatyvaus požiūrio. Labai svarbu yra suprasti esminius faktorius darančius įtaką inovacijų vystymui aukštųjų technologijų sektoriuje. Pagrindinis šio straipsnio tikslas yra įvertinti aukštųjų technologijų sektoriaus raidos specifiką ir galimus valdymo instrumentus. Atvirų inovacijų teoriniai tyrimai atskleidžia inovacijų perdavimo kryptingumą ir tinklaveikos struktūrų formavimąsi. Nagrinėjant šią tematiką svarbu atkreipti dėmesį į atvirų inovacijų poveikį regioniniame kontekste ir sektorinius inovacinės veiklos netolygumus, kurie sąlygoja naujo tipo vadybinio instrumentarijaus poreikius.

Raktažodžiai: atviros inovacijos, aukštųjų technologijų sektorius, internacionalizacija, mokslinių tyrimų plėtra, didelio poveikio technologijos, žinių perdavimas, inovacijų procesai.