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DETERMINANTS OF DEVELOPMENT OF THE HIGH-TECH MANUFACTURING SECTOR IN POLAND

Abstract

Today the companies that mostly make use of the latest scientific, technical and technological achievements are those which belong to the sector of high technology. These firms are based on the processing of the results of research in industry and are characterised by high expenditure on research and development. Technologically advanced goods are an effect of enterprises belonging to the sector of high technology. Therefore, the share of this sector in the economy largely determines the pace of economic growth. Due to the high intensity of the processes of research and development, analysis of the high-technology sector provides information about the impact of the activities of R&D, competitiveness and the capacity of the economy to absorb the results of work in areas of science and technology.

Unfortunately Poland does not take part in the dynamic development of the high-tech sector. It is characterised by a very low share of high-technology products in total sales. The reason of encountered technology gap in the Polish economy may be the lower level of the ability to compete of many Polish products on the world market, reducing the productivity of many foreign technology used in Polish industry or the excessive consumption of materials, raw materials and energy.

In order to ensure the long-term and effective economic growth, Poland need to develop industries of high-technology. Integration, globalization and internationalization of production can increase the production of high-technology in Poland. The aim of the paper is to identify determinants of development of high technology manufacturing sector in terms of Polish economy.

Keywords: high-tech manufacturing sector, determinants of development.

Introduction

It is possible to reach a conclusion that the level of economic growth of the developed countries is strongly dependent on industries of the high technology. The development of enterprises belonging to this sector is one of the basic factors of the structure and the development of the economy based on knowledge. These manufacturers should be the source of the creation of new knowledge, inventions and the innovation.¹ High-tech manufacturers are taking a risk of new technical solutions. They are also expecting high resulting benefits from this activity.

1. Characteristics of the high-tech manufacturing sector in Poland

Over the years a structure of the high-tech manufacturing sector has changed. At every stage of the manufacturing growth it was possible to distinguish such fields which could be described as “modern”. Thanks to the above mentioned structural transformations it became possible to achieve of the basic objectives, such as:²

- increasing the pace of the economic growth,
- preparing the economy for the future objectives,
- providing for the high economic effectiveness of the economy.

At every stage of the economy growth it is possible to single out the branches of industry and the fields of the production based on the latest technical achievements which are often called leading or dynamic branches.³ These branches include:⁴

- the highest growth rate,
- impact of the technical transformation in other industries and other sectors of the economy,
- creating new production and consumer demand,
- innovativeness.

¹ K. Koziół, *Rozwój przedsiębiorstw wysokiej technologii w Polsce (kontekst regionalny)*, *Wiedza i innowacje w rozwoju polskich regionów: siły motoryczne i bariery*, ed. S. Pangsy-Kania, Fundacja Rozwoju Uniwersytetu Gdańskiego, Gdańsk 2007, p. 172.

² W. Popławski, *Mechanizmy procesów innowacyjnych w rozwoju przemysłów wysokiej techniki*, Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń 1995, p. 39.

³ A. Karpiński, *Restrukturyzacja gospodarki w Polsce i na świecie*, PWE, Warszawa 1986, p. 32.

⁴ J. Kleer, *Gospodarka światowa i prawidłowości rozwoju*, PWE, Warszawa 1975, p. 49.

Leading branches stimulate the quantitative and qualitative growth in the form of structural changes. They also saturate structures with new solutions, raw materials and capital goods.⁵

R. Premus specifies three following criteria referring to the high-tech manufacturing sector:⁶

- higher than the average expenditure on R&D,
- higher than the average participation of researchers in the total number of the employed,
- access to the scientific base.

It is possible to state that enterprises belonging to the sector of high technology should be characterized by a higher than average level of modernity. However, the term of the modernity in the industrial areas is not that simple and obvious to understand. It is possible to enumerate a few levels of the modernity, that is: the participation of modern fields of production, the modernity of products and/or technological processes, as well as the modernity of management methods and the scope of the classification and standardization of products, also cooperation and specialization of the industrial production.⁷ In Poland modern branches of industry are those which are very similar to the most developed countries due to their participation in the production, that is mainly creating and transferring the knowledge branches. The level of knowledge is conditioned by human attitude to the environment, which comprise both financial and immaterial elements.

In broadest terms high-tech manufacturing sector should be characterized by high technical intensity, that is high participation of knowledge included in the defined product or the process. It is possible to express the included knowledge with the number of researchers in the total number of the employed or with the participation of the expenditure on the research and development work in the general value of a company's sales.⁸ With reference to the whole industry it is possible to use the value of the expenditure on research activity related to the value of industrial produc-

⁵ W. Popławski, *op.cit.*, p. 40.

⁶ R. Premus, *Location of high technology firm and regional economic development. A staff study for the use of the Subcommittee on Monetary and Fiscal Policy*, Congress of the USA, June 1st, Washington D.C., 1982.

⁷ *Ekonomika i programowanie przemysłu*, ed. J. Gajda, PWN, Warszawa 1982, p. 20.

⁸ E.J. Malecki, *Industrial location and corporate location in high technology industry*, "Economic Geography" 1985, No. 4, p. 79.

tion.⁹ On the scale of total economy, the intensity of R&D is calculated with participation of expenditure on these activities in the gross national income.

Increasing interest in high-tech manufacturing sector is a result of growing desire for achieving more and more growth of industry. This industry is a provider of new generations of products and new production technologies. However this is not an only factor of this growth. More beneficial functioning of enterprises which have comparable technical level can be ensured by better marketing or better labour organization.¹⁰ In the economy which is open to world market the effectiveness of production achieved in the industry is possible when the quality of the workforce, the organization of production process and natural conditions of acquiring natural resources are appearing in the majority in the given economy in comparison to other economies. Nevertheless, achieving the growth in the economy is possible thanks to directing the industry at these branches which are achieving the higher work output and higher productivity of the remaining production factors.

Polish economy is made conditional to a large extent on the international exchange. The industrial policy should be distinguished by high export. The growth of industry should be concentrated, among others, on the exploitation of natural resources where achieving competitive benefits is possible, as well as on rehabilitating industrial activity and stimulating the growth of these branches of the processing industry whose products are competitive on world market.¹¹

The success of new solutions in the modern industry is strongly dependent on interrelations between authors of ideas and their contractors. The scientific knowledge is based not only on information resources which are contained in publications but also on information resources gained through cooperation of employees in the research institutions and the employees responsible for the development of technology in production units.¹²

According to his 1997 studies, T. Hatzichronoglou includes to high-tech manufacturing sector these enterprises which allocate to their R&D activity over 7% of

⁹ A. Romeo, *Interindustry and interfirm differences In the rate of diffusion of an innovation*, "The Review of Economic and Statistic" 1975, No. 3 (57), p. 311.

¹⁰ W. Popławski, *op.cit.*, p. 38.

¹¹ *Ibidem*, pp. 81–82.

¹² A. Thomas, *Managing the flow of technology*, Cambridge Mass 1977, pp. 52–54.

sale values. According to the Polish Classification of Activities from 2007 we can distinguish three groups of high-tech manufacturers:¹³

- manufacturers of pharmaceutical products,
- manufacturers of computer, electronic and optical products,
- manufacturers of aircrafts and spacecrafts.

The following table presents the indices of sold production, average paid employment and average monthly gross wages and salaries.

Table 1. The indices of sold production, average paid employment and average monthly gross wages and salaries

| 2011 | Sold production | | Average paid employment | | Average monthly gross wages and salaries | |
|--|-----------------|------------|-------------------------|------------|--|------------|
| | millions PLN | 2010 = 100 | thousands PLN | 2010 = 100 | PLN | 2010 = 100 |
| Manufacturing | 776,330.5 | 107.2 | 1,606.6 | 101.3 | 3,443.07 | 105.8 |
| Manufacturers of pharmaceutical products | 10,378.9 | 87.4 | 20.5 | 94.9 | 5,344.70 | 102.8 |
| Manufacturers of computer, electronic and optical products | 31,406.0 | 95.2 | 48.5 | 95.6 | 3,276.08 | 99.3 |
| Manufacturers of aircrafts and spacecrafts | 3,189.2 | 122.5 | 13.9 | 101.8 | 3,916.02 | 112.7 |

Source: *Outlays and results in industry in 2011. Central Statistical Office.*

As it can be seen from the table, in contrast to the whole manufacturing sector, the indices of sold production, average paid employment and average monthly gross wages and salaries in 2011 for high-tech manufacturing sector characterised with a downward trend. Manufacturers of air and spacecraft were the exception, in which all exchanged values of indicators considerably grew, so it has improved. However this production is characterized with minimum values of indicators in comparison to other manufacturers belonging to the high-tech manufacturing sector. Moreover a low percentage share of high-tech manufacturing sector in the comparison to the whole industry is noticeable. Only nearly 6% of the sold production in 2011 belonged to the high-tech manufacturing sector. The similar relation is in the participation of

¹³ Eurostat, *Working Group Meeting on Statistics on Science, Technology and Innovation*, Luxembourg 27–28 November 2008.

the employed in this sector. About 5% of employees in the industry are employees of the high-tech manufacturing sector.

To sum up, it is possible to state above tendencies that Poland is characterized by a very low share of high tech products in the total sale value. The expanding technology gap in Poland results among others from:¹⁴

- lowering the level of the competitive ability of many Polish products on world markets,
- distinct competitive edge of the foreign production,
- reducing the productivity of many foreign technologies applied in the Polish industry,
- exaggerated material, raw materials and energy consumption,
- exaggerated diversity of products in one enterprise, hampering the specialization and the reduction in unit costs.

In contrast with Poland the developed countries notice in the development of high-tech manufacturing sector the huge chance of the rise in the national income and at the same time the prosperity of citizens, as well as the chance of filling the prominence in the international dividing up of work. These countries are allocating huge financial means in the high-tech manufacturing sector development. For this reason distinguishing all possible determinants of the development of the high-tech manufacturing sector and indicating the ones which are most essential for enterprises belonging to this sector in conditions of the Polish economy is necessary.

It is possible to classify factors of the high-tech manufacturing sector in a lot of ways. A division into internal and external determinants is one of the most general divisions.

2. Internal determinants of the high-tech manufacturing sector in Poland

The development strategies of industrial enterprises belonging to the sector of high technology the company should be based both on internal, as well as external sources of the innovation of this sector. Initiating the high-tech strategy in Polish enterprises should be based mainly on internal factors of the growth of high-tech manufacturing sector.

¹⁴ W.M. Grudzewski, I.K. Hejduk, *Zarządzanie technologiami. Zaawansowane technologie i wyzwanie ich komercjalizacji*, Difin, Warszawa 2008, p. 48.

Expenses are one of the significant conditions of the high-tech manufacturing sector growth. The amount of this expenditure is determined, among others, by: the size and the complexity of the undertaking, the scope of innovative solutions and the level of the knowledge and experience of employees.

Undoubtedly, it is possible to rank the factor of the work among internal factors. Considering the incurred heavy costs spent on employees, often living work is replaced with technical devices. However, in the high-tech industry it is not impossible to eliminate the human factor so easily. In analysed enterprises we are dealing with two categories of employees with high qualifications:¹⁵

- highly skilled workforce on managerial positions of the enterprise and in research-developmental department,
- highly skilled workforce on implementation positions.

In Poland the high tech enterprises value high qualifications of the staff more than enterprises in all the manufacturing sector. Higher expenditure on training attests to it.

In order to build their technical capacity industrial enterprises can use such sources of reviving the innovative activity as the purchase of the licence, or employing specialists from the country in which the given technology has already been mastered. However this action is not able to provide the position of the leader for the enterprise. The company's own potential, that is high qualifications of its employees who are involved in research processes, is essential. Appropriately educated and experienced staff is able to change any project into his material form quickly and competently.

High qualifications of the workforce come in handy particularly in these enterprises in which short series appear and in which the comprehensive control is necessary. The high innovativeness of the production requires professional qualifications of employees to grow. It particularly concerns these employees who prepare the production and supervise the production processes.

Despite the highest level of the technology, modern enterprises need above all appropriate management methods, as well as strong marketing, planning and strategy. The efficient influence of the above factors guarantees not only the highest level of knowledge, but also higher experience.¹⁶

¹⁵ W. Popławski, *op.cit.*, p. 115.

¹⁶ *Ibidem*, pp. 115–117.

Technological innovations need also a research-developmental potential which should be understood as the ability of the enterprise to create new or improve already existing technical solutions. This potential is able to become known thanks to the possession or access to the qualified staff who are equipped with appropriate technical devices. The research-developmental base allows for slashing the expenditure of the enterprise at the stage of implementations, shortening the time between the invention and the implementation. However it is possible mainly when the following conditions are fulfilled:¹⁷

- the idea should be understood by people who are dealing with converting the invention into the innovative solution,
- the idea should be considered and discussed by directors and research employees with sympathy and understanding,
- possibility of implementing the alternative solution,
- the idea which was accepted should become prepared for the implementation and immediately administered by the contractor.

During the research and development work performed by means of technical equipment, that is the production non-current assets of enterprises, with the help of which its innovative solutions are carried out is becoming a need.¹⁸ Machines, devices being directly involved in a manufacturing process, and also equipping laboratories and other research-developmental cells are included in a technical equipment. Because of heavy costs of these devices, enterprises are often limited in the access to the appropriate technical equipment.

Except for the technical equipment, extremely important component of every enterprise should be also a technical infrastructure which is also composed of energy and communication devices. The significance of the technical equipment results mainly from the fact that the raw material and the energy are factors which are essential to produce every product. In high-tech manufacturing sector different forms of the energy are required, but the highest weight is being granted on these energy sources which are characterized with the best quality and the guarantee of the uninterrupted delivery.¹⁹

¹⁷ *Ibidem*, pp. 119–120.

¹⁸ M. Patibandla, B. Petersen, *Role of Transnational Corporations In the Evolution of a High-Tech Industry: The Case of India's Software Industry*, "World Development" 2002, Vol. 30, No. 9, p. 1547.

¹⁹ W. Popławski, *op.cit.*, p. 121.

A communication system, that is not only an available and reliable transport, but also a wide access to the information, as well as a possibility of its exchange are necessary in high-tech manufacturing sector. The development of the modern industry depends on the efficient transport among the enterprise and teams dealing with research. Except for a direct contact with units dealing with learning and R&D activity, enterprises should also use other sources of innovations, that is among others: publications, projects, patents, computer programs. The access to the information about new technical solutions helps overcome barriers in implementing innovations.

In Poland some signs of enterprises' cooperation in the R&D field are appearing. Very often it results from the lack of information about such possibilities, and sometimes even from poor access to capital.

3. External determinants of the high-tech manufacturing sector in Poland

External determinants of the growth of high-tech manufacturing sector are able to create and to control the innovative process. However this influence can not only stimulate, but also curb the development of the advanced technology.²⁰

An access to the information and knowledge about new technology are two of the most important external factors affecting the success of enterprises of the modern industry.²¹ Very often a situation takes place when, in spite of information resources about some solutions, the access to this information is limited due to institutional barriers.²²

A store of knowledge, resulting from the scale and dynamics of the research-developmental activity, as well as the business environment's readiness to implement innovations contribute to the growth of enterprises belonging to high-tech manufacturing sector. Thanks to increasing a store of knowledge being found in an environment, the reduction of future costs of innovative solutions is possible. Most often the expenditure on R&D supports the technological progress and the technological progress supports investments in R&D. The R&D sphere is very important for enterprises belonging to high-tech manufacturing sector in Poland, because expenditure

²⁰ *Ibidem*, pp. 112–113.

²¹ M. Patibandla, B. Petersen, *op.cit.*, p. 1549.

²² W. Popławski, *op.cit.*, p. 106.

on this activity in high-tech sector is repeatedly higher than expenditure in all the manufacturing sector. In spite of comparing to the developed countries Poland is characterized by a small stake of the expenditure on R&D activity in the relation to the gross domestic product. In 2009 this share amounted to only 0.67%.

Considering the fact that the innovative process requires considerable financial outlays on new and risky ventures and that the amount of the expenditure is often a strong barrier in the development of enterprises, capital institutions which have a venture capital at their disposal are a crucial element of surroundings. Expenses are incurred for R&D activity among others, equipping enterprises with production factors, raising qualifications of employees or also for investments related with the implementing innovation. The enterprise is more willing to implement new technical solutions, when it could acquire capital to finance them. This financing is easier when the foreign capital is involved. Unfortunately the share of enterprises with foreign capital in the high-tech manufacturing sector is low. It is mostly due to the complexity of administrative procedures, clumsy functioning of administration and judiciaries, as well as the complicated and changeable tax system.

An availability of production factors, the change in their prices, as well as the change in sizes and the structure of the demand have a very strong impact on high-tech manufacturing sector. If problems in gaining production factors or an excess demand appear, the rise of production factors price will contribute to seeking reduced consumption or seeking substitutes in the form of new technical solutions.²³ To increase innovative capacity of enterprises, the improved university and technical education system and an better system of research centres are essential.

An influence of the market which can increase innovative activity is a significant development factor for enterprises belonging to the high-tech manufacturing sector. Nowadays enterprises that do not take up such actions are threatened with the loss of their competitive position. That is why enterprises should have a proactive attitude towards external factors, focusing their attention on market behaviour and predicting the demand for their own products. The unstable market is very often an effect of repelling the association between the science and production. Apart from the import of foreign advanced technology, companies should develop their own research activity, thanks to which they will be able to improve their own solutions.²⁴

²³ *Ibidem*, pp. 112–114.

²⁴ *Ibidem*, pp. 124–125.

When talking about external factors it is necessary to mention the competition. At present the level of science and technology is a crucial factor determining the competitive ability of a country. Therefore the development of the high-tech sector triggers positive changes in this domain. The heightened technological competition among enterprises belonging to this sector is contributing to constant improving quality parameters of products.²⁵ It is necessary to observe developmental trends of enterprises, their activity in certain fields, as well as the continuation of their tradition. However, maintaining the competitive position is possible above all by constantly involving the enterprises in innovative undertakings. Enterprises should respond to the emerging high-tech solutions with appropriate anticipation.²⁶

In the market economy, the stability of trade relations is important for the enterprise.²⁷ With them in mind more products of the enterprise are adapted to individual requirements of customers. All the more it strengthens the relations with customers, as well as their loyalty to the supplier.

So that the innovative process can run quickly and without obstacles, the relations of an enterprise with surrounding institutions from the following fields are necessary: banking, credit, insurance, scientific, educational and cultural institutions. It is essential for the development of high technologies, particularly for proper operation of channels of the transfer of knowledge between the science sector and the industry. Diffusing the innovation between industries is possible when all exchanged elements are cooperating with themselves.²⁸ Nowadays large transnational corporations and direct investments made by them are a basic element of changes in conditions of the Polish economy.²⁹ Because of that direct investments carried out by transnational corporations can turn out to be the main external development factor of the high-tech manufacturing sector in Poland.

²⁵ K. Turowski, *Rozwój sektora wysokich technologii a konkurencyjność polskiej gospodarki. Przemiany i perspektywy polskiej gospodarki w procesie integracji z gospodarką światową (tom 1)*, Instytut Wiedzy, Warszawa 2002, pp. 304–305.

²⁶ W. Popławski, *op.cit.*, p. 118.

²⁷ A. Świdurska, *Efektywność rozwoju przedsiębiorstw produkcyjnych wysokiej techniki w Polsce*, Prace Komisji Geografii Przemysłu, nr 15, Warszawa–Kraków 2010, p. 204.

²⁸ W. Popławski, *op.cit.*, pp. 122–123.

²⁹ M. Patibandla, B. Petersen, *op.cit.*, pp. 1561–1564.

Industrial policy, which is focused on modernity should be consistent, orderly, and should contribute to the development of high-tech industry.³⁰ The government is able to directly influence the development of high-tech manufacturing sector through the use of various types of financial and tax policies, such as low-interest loans, shares in the capital, tax, double taxation avoidance, etc.

Undoubtedly the living standards of the society, in particular their increased mobility and higher level of satisfied needs are ones of the most important external determinants of the high-tech manufacturing sector.³¹ As a result of the evolution of consumer habits, an increasing demand for high technology is appearing in the world which it can contribute to larger exports and improved competitive position of the Polish economy on the international market.³²

Conclusions

When comparing data from the last years we can say that the high-tech manufacturing sector is marked by the highest level of the innovation, as well as with high expenditure on R&D and the human capital. Thanks to that a subsequent development of enterprises of the high technology sector in Poland is possible. The sector is likely to become one of the vital elements of modern economy, because it is the carrier of technological progress and of the indicators of innovative activity. On the other hand they still differ greatly from the indicators observed in the developed countries.

³⁰ W. Popławski, *op.cit.*, p. 123.

³¹ *Ibidem.*

³² K. Turowski, *Rozwój sektora wysokiej techniki jako czynnik poprawy międzynarodowej pozycji konkurencyjnej polskiej gospodarki*, w: *Polityka gospodarcza państwa*, ed. D. Kopycińska, Katedra Mikroekonomii Uniwersytetu Szczecińskiego, Szczecin 2008, p. 263.

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DETERMINANTY ROZWOJU PRZEMYSŁU WYSOKIEJ TECHNIKI W POLSCE

Streszczenie

W dzisiejszych czasach przedsiębiorstwa, które w największym stopniu wykorzystują najnowsze osiągnięcia naukowe, techniczne i technologiczne to te, które należą do sektora wysokiej techniki. Są to przedsiębiorstwa powstające na styku nauki i przemysłu, które bazują na przetwarzaniu wyników badań naukowych w przemyśle i charakteryzują się wysokimi nakładami na działalność badawczo rozwojową. Efektem przedsiębiorstw należących do sektora wysokiej techniki są zaawansowane technologicznie dobra. Z tego względu udział tego sektora w gospodarce w znacznym stopniu określa tempo wzrostu gospodarczego. Z uwagi na wysokie natężenie procesów badawczych i rozwojowych, analiza sektora wysokiej techniki dostarcza informacji zarówno o wpływie działalności B + R, jak i konkurencyjności oraz zdolności gospodarki do absorpcji rezultatów prac dziedzin nauki i techniki.

Niestety w dynamicznym rozwoju sektora high-tech nie uczestniczy Polska. Charakteryzuje się ona bardzo niskim udziałem produktów wysokiej techniki w ogólnej wartości sprzedaży. Powiększająca się luka technologiczna w polskiej gospodarce wynikać może chociażby z obniżenia poziomu zdolności konkurencyjnej wielu polskich produktów na rynku światowym, zmniejszenia produktywności wielu stosowanych w polskim przemyśle technologii zagranicznych, czy też nadmiernego zużycia materiałów, surowców i energii. W celu zapewnienia Polsce długookresowego, efektywnego wzrostu gospodarczego konieczny staje się rozwój przemysłów wysokiej techniki. Zwiększeniu produkcji wysokiej techniki w Polsce sprzyjają takie cechy współczesnej gospodarki światowej jak chociażby: integracja, globalizacja, internacjonalizacja produkcji.

Słowa kluczowe: sektor wysokiej techniki, determinanty rozwoju.