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Article

Is Innovation a Risky Business? A Comparative Analysis in High-Tech and Traditional Industries in Poland

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Abstract: A high level of innovativeness and technology complexity is most often associated with a faster and more dynamic pace of economic development. In turn, it enables enterprises to achieve better financial results and strengthen their competitive advantage. Despite these potential benefits, in practice, innovation is also associated with the need to take up new challenges, which may be accompanied by a higher risk. The main goal of the research is a comparative analysis of the relationship between innovation and the risk of running a business in traditional and high-tech industries exemplified by the Polish economy. The authors assess the risk in 44 enterprises in the years 2010–2020 based on the proprietary evaluation model that uses the variation of financial parameters associated with innovativeness. The obtained results indicate a higher level of risk in the high-tech group with more complex and modern technologies, in particular in the pharmaceutical and computer games sectors. In the group of traditional enterprises, the risk in the analysed sectors is more diversified, and it is much higher in manufacturing enterprises than in services and trade. The empirical and quite extensive nature of the research allows for a practical assessment of the direction and strength of the relationship between innovation, risk and technology complexity.

Keywords: innovativeness; technology and its complexity; risk in innovative activity; the impact of innovativeness on risk; innovativeness in high-tech and traditional industries

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1. Introduction

Innovations are the driving force of an economy. The socio-economic and development of civilisation depends on their scope and scale. This is not only confirmed by numerous scientific publications [1–6], but also by observations and economic analyses [7] carried out for the most developed countries, where the high quality of life is associated with an above-average level of entrepreneurship and innovation [8–11].

The indisputableness of the above observations and research results necessitates continuous efforts to strengthen innovation at various economic levels. On a macroeconomic scale, the efforts of government decision-makers focus on the creation and development of a system of national innovations that are to foster the creation and diffusion of knowledge in the system of successive economic helices, including: science, business, government, society, and ecological organisations [12–16]. On a mesoeconomic scale, the development of entrepreneurship and innovation is ensured by local authorities establishing business incubators, parks and technology centres, and acting to strengthen local and regional cooperation within the aforementioned economic helices [17–20]. On a microeconomic scale, innovation is the responsibility of enterprises located within individual industries characteristic for the development of a given economy [21,22].

Therefore, the effectiveness of efforts to strengthen innovation depends on the activities of many entities and the relationships between them. It is also influenced by economic and social determinants specific to a given economy [23–27]. The complexity and multiplicity of factors shaping innovation [28–34] becomes a source of intense risk at each of the aforementioned levels. This risk—as we know it—accompanies every economic decision,

but in the case of innovative activity, it is additionally linked with a higher unpredictability of the results of undertaken actions and a higher probability of failure of these actions. In turn, this results from the uniqueness and novelty of innovation, and hence the lack of the so-called history of experience and historical data facilitating forecasting the effects of economic decisions.

In general, the level of risk associated with innovation increases with the complexity and novelty of the technologies used in their development and implementation [35,36]. This increases the area of uncertainty and the scope of threats to the success of innovation and the possibility of its placement on the market [37]. Therefore, innovative activities are a challenge and require more than average commitment, creativity and entrepreneurship [38,39]. In the event of opening up innovations, enterprises must additionally cope with the reduction of competitiveness due to the publication of technological solutions. Nevertheless, they can gain a stream of feedback, which is also an inspiration for further activities and improvement of products or services.

Therefore, the risk accompanying innovations differs from the typical risk of running an already identified business. Meanwhile, in the literature on the subject and the research to date on the risk associated with innovation, relatively little attention is paid to the factors stimulating innovation, i.e., with a positive impact on its level [40–44]. This may result in omitting a significant inhibitor of innovation and ignoring the possibility of mitigating risks related to its final level.

Bearing in mind the above circumstances, the authors of this article undertook the analysis and assessment of the impact of enterprises' innovativeness on the risk of running a business. Research on this issue has been embedded in the Polish economy, classified as an emerging economy, but with a considerable distance to catching up to in terms of innovation in relation to many EU countries [45–47]. The last report of the European Commission (European innovation scoreboard 2021—main report) [7] shows that Poland belongs to the group of so-called moderate innovators, but it is only 24th place out of 27 EU countries assessed in terms of innovation. Only Romania and Bulgaria, already belonging to the group of so-called moderate innovators and Croatia as a country that completes the group of moderate innovators. Results of the European ranking are therefore an additional, practical premise for undertaking research in the area of innovativeness of Polish enterprises.

Two groups of enterprises were included in the research on the relationship between innovation and business risk:

(1) The high-tech sector (including biotechnology), naturally predisposed to innovative activities, in particular product and process ones (more complex and advanced), and
(2) The traditional industry, where innovations are usually of less technological advanced nature and often take the form of organisational and/or marketing innovations (less complex and advanced).

The first group included 18 enterprises from the medical, pharmaceutical, telecommunications and IT industries. The second group includes 26 enterprises from such sectors as: chemical, fuel and energy, construction, trade and services. In total, the sample included 44 entities listed on the Warsaw Stock Exchange. The structure of the sample selected in this way reflects the industry structure of the Polish economy, which is still dominated by traditional industry, largely being an aftermath of the communist centrally planned economy [48].

The obtained results contribute to research on the relationship between innovation (its complexity and advanced) and the risk of running a business. This topic is relatively seldom discussed in the literature on the subject, and its further exploring may be helpful both in better understanding the mechanism of innovation and in mitigating the risks associated with its increase in its level. Moreover, the research methodology proposed by the authors—based on classical measures of variation and taking into account the areas of disclosing the financial results of innovations—is universal and can be used in the process of assessing the risk associated with innovations in any enterprise. Thanks to this, it can

also be useful in regional and international comparisons, which is the second scientific value of the considerations.

The empirical and quite extensive nature of the research allows for a practical assessment of the direction and strength of the relationship between innovation and risk. This assessment is additionally carried out in a comparative approach in relation to the high-tech and traditional sectors, which increases the scientific and research value of the conducted analyses and more strongly directs the conclusions to practical recommendations for both research groups. Due to the two-sided nature of research covering the sector and individual entities, the research results can be used by both decision-makers from the macro and mesoeconomic level of the innovation system, as well as managers managing the surveyed enterprises.

In the context of the geographical universality of the considerations, it should be noted that the results of the research may contribute to economic analyses in other emerging and developing economies, primarily including those which in the European innovation scoreboard were behind Poland (3 countries) and, together with Poland, make up the moderate group of innovators (11 countries).

2. Literature Review

2.1. Innovation in Terms of the Industry

Innovation means the ability to create innovation. Therefore, if an enterprise has such an ability, it is considered innovative. The more innovations they can generate and implement, the higher their innovativeness becomes. In the Oslo Manual, the innovation of an enterprise is quite precisely dimensioned, because only those enterprises that in the short term (up to three years) have introduced at least one product, process, organisational or marketing innovation to the market [49] can be considered innovative. This condition does not seem difficult to meet if we take into account the Schumpeter's definition of innovation, assuming its very broad approach [50–52]. In this approach, innovation means one of the following circumstances [53]:

1. introducing a new product that customers have not yet used or giving new features to an existing product,
2. implementation of a new production method not previously used by the industry concerned,
3. opening up a new market where the industry has not previously operated,
4. acquiring new sources of production raw materials,
5. introduction of a new organisational structure in a given industry.

In light of the above the minimum requirement for an innovation to occur is therefore only that the product, process, organisational or marketing method is new or significantly improved for the enterprise [54].

The above-described approach to innovativeness, innovation and innovative enterprise means that every enterprise can be innovative, regardless of industry affiliation. Nevertheless, the most creative and innovative sectors of the economy that emerged in the course of the fourth industrial revolution in the 20th and 21st centuries are considered to be the most creative and innovative. These are mainly those industries that use high-tech that enable the production of very advanced products, i.e., primarily the telecommunications and IT industries. As the research of Blichfeldt and Faullant [55] has shown, digital technologies are a catalyst for breakthrough innovations and a source of higher efficiency for enterprises that implement them.

The industries listed above are related to digitisation, automation, robotisation and the development of artificial intelligence. The impact of these industries on the development of the economy and civilisation is extremely intense and significant. However, their existence and the ability to create innovations are in practice associated with the need to have very advanced knowledge and competences as well as significant financial resources, which very often complicates their development in less developed economies than the world's economic leaders.

Industries with a high innovation potential also include sectors that develop in accordance with the concept of sustainable development, which emphasises the need to provide

decent living conditions for future generations and the need to take into account social and environmental priorities in economic life [56]. In line with these ideas, eco-innovations as well as products and services in the field of health protection are developing intensively.

Growing environmental pollution around the world is forcing scientists and entrepreneurs to search for products, services and manufacturing methods aimed at cleaner, more sustainable consumption and production [57,58]. The problem of waste generated by households and industry is also a huge challenge [59,60]. Solving this problem requires innovative, efficient and effective recycling methods. Eco-innovations are also necessary in the process of transforming energy systems towards greener energy [61–65]. Therefore, a circular economy cannot arise and develop without innovation. As different research show [66–68], the development of eco-innovation can be effectively supported and stimulated by legal environmental regulations in all the above areas.

In turn, the health products and services sector (medical and pharmaceutical) is developing to a large extent in response to growing demographic problems, including, in particular: ageing societies, overpopulation, diseases of civilisation, etc. The demand for innovation in this industry is also increased by growing expectations in terms of improving the quality of life and extending it [69–71].

In traditional industries, the innovation boom is much smaller, which in a way results from the phase of life in which these industries are located. It is usually a phase of full development or a declining one, in which the necessity to introduce innovations is not a priority for entering the market. The stabilised or declining demand for services and/or products of enterprises operating in these industries does not force radical changes. Often the problem is also the lack of interest on the part of capitalists and investors who prefer more developmental and profitable ventures offered by the high-tech industries described above [72–74].

However, the above circumstances do not exclude the possibility of creating innovations by these industries [75], all the more so as they may be an opportunity for them to remain in the development phase, or to exit or extend the decline phase. The research by Blichfeldt and Faullant [55] showed that in traditional industries, innovations may contribute to maintaining or improving the current competitive position. Therefore, they are important for the survival and development of these industries. In this context, innovations are particularly important for the coal mining and metallurgy industry using coking coal [76], considered in the European Union as an industry that poses a serious threat to the environment and health.

It is also worth noting that traditional industries are often very good at using and implementing modern technologies, but they do not produce them on their own. Therefore, they do not incur expenditure on R&D and are rated low in innovation rankings, which is emphasised in studies conducted in the mining sector by Mahdavimazdeh et al. [77].

When writing about innovation, it is impossible to ignore the issues related to financing. Expenditures on research and development and implementation of innovations differ significantly from traditional financing of investments [78–82]. Acquiring qualified personnel, including creative and talented managers, also requires above-average salary expenses. All this means that many enterprises cannot afford innovation, the more so as the effects of innovation are often postponed and carry a significant risk (risk of not achieving the planned revenues).

Problems with financing innovation are particularly serious in developing economies due to their lower national income. This makes it impossible to support innovation at the national level and limits financial transfers to innovative enterprises. In Poland—which is the subject of the analysis conducted in the article—innovations are financed from private and public sources. The public sources are mainly related to subsidies from the European Union. In the years 2007–2013, this source was primarily the Innovative Economy Operational Program. In the period 2014–2020 it was replaced by the Operational Program Innovative Development and Horizon 2020. This financing was strengthened by regional programs as well as the European venture capital funds (EuVECA) and Programme for the

Competitiveness of Enterprises and small and medium-sized enterprises (COSME). The size and multiplicity of EU funding sources emphasise their importance in building Polish innovation [83]. Currently, Poland is waiting for the next tranche of EU funding.

Private sources of financing innovation include equity and debt, and their level and types are reflected in the capital structure. It is worth adding that in this respect Polish enterprises have at their disposal their own capital market and the possibility of issuing shares on the Warsaw Stock Exchange and the New Connect market. Nevertheless, these forms of development financing, as well as the issue of corporate bonds, are not the most popular. Venture capital and private equity are also of low interest. A bank loan has been the dominant source of financing innovative activities in Poland for many years. This limits the variety of financing innovations, and thus their possibilities of their creation and implementation [84].

2.2. Risk in Innovative Activity

Risk accompanies every economic decision. It means that the actual result of the decision may deviate from the originally planned result. The risk cannot be eliminated because the future is never known, and the consequences of economic activities cannot be planned without error [85]. However, risk can be managed to prevent threats and minimise losses due to the possible occurrence of those threats.

The effectiveness of risk management largely depends on the proper identification and assessment of the type and scale of possible threats [86]. At the same time, the better known and/or more frequent the phenomena and processes responsible for the emergence of risk, the more accurate and complete their identification and assessment are. Therefore, better identification of threats creates an opportunity for faster and more effective risk mitigation measures.

As Klinke emphasises, in risk management, a rational approach to threats is important. They cannot be post-sorted only in the emotional context, which is particularly important in the case of innovations, i.e., new unknown ventures. You cannot be afraid of them; you must see them as an opportunity for development and increasing efficiency [87]. Customers are also concerned about the risks associated with innovation. As demonstrated by Sarin et al. [88] this is an important deterrent to the purchase of a new product or service. Therefore, it is worth linking innovations to existing technologies to make them user-friendly.

In the case of innovative activities, the intensification of threats, and thus the risk, is due to the novelty and uniqueness of the proposed solutions [88–90]. Originators and creators of innovation are not able to predict the final effects of its development and implementation because they do not have historical data, information or knowledge about a given solution. Additionally, the risk accompanying innovative ventures may intensify simultaneously in the technological [91], market [92–94] and financial spheres. In a completely new and unpredictable situation, both the probability of successful implementation and the reactions of recipients as well as the final economic effectiveness of innovation are unknown.

The complexity and advancement of technologies used in the process of creating innovations increases the scope of threats and thus the risk. This is due to the large scale of resources involved and the long development and implementation period of such innovations [95–97]. Therefore, it can be concluded that product innovations (more complex and technologically demanding) are characterised by a higher innovation risk than process or service innovations with a smaller scale and using fewer resources [98,99].

The above circumstances may contribute to a higher risk exposure of those enterprises whose activities require the development and implementation of innovations. Many studies show that enterprises considered to be innovative are more willing to take risks [100,101]. Some of them even generate market changes themselves to gain technological leadership in conditions of increased risk [102,103]. Nevertheless, it does not have to a rule due to two key circumstances. The first of them may be the effectiveness in implementing innovations, which translates into a high rate of market success. The second may be the effectiveness in

managing the risk of innovation, minimising the deviation of the results achieved from the desired ones [104–107].

In the literature on the subject, there are studies that indicate both the intensification of risk in more innovative enterprises, as well as those that prove the positive impact of innovation on risk reduction. Thus, Zaman et al. [108] states that eco-innovations reduce the market risk of enterprises because they are of great interest to investors, including institutional investors, which positively affects the image of innovative enterprises, increases their credibility and prevents sharp fluctuations in stock exchange quotations.

In practice, managers seem to share the conclusion that innovation comes with a higher level of risk. Research by Zhou et al. [109] shows that as the risk associated with the development of innovation increases, expectations regarding the level of remuneration increase. The bonus for innovation must therefore be higher than for standard activities. However, according to the analysis of García-Granero et al. [110], the payment of such an additional premium may be very profitable, because the high risk propensity of managers influences the growth of innovation. Similar observations result from the research by Hock-Doepgen et al. [111], in light of which small and medium-sized enterprises with higher risk tolerance are more willing and more intensively use knowledge obtained from the outside to develop innovations. However, it is worth supplementing these conclusions with the observation that the relationship between the risk propensity and the level of innovation is not directly proportional, because, as shown by Howell [112] from research on the Chinese economy, more cautious innovators have a chance for a higher risk premium than excessive risk-takers.

Reguera-Alvarado and Bravo emphasise the importance of the experience and knowledge of management in risk reduction. Based on the results of the research, they note that hiring experts with experience in the high-tech industry on boards can positively affect innovation in low-tech enterprises [113].

Huang and Yao expand the scope of human resources impact on risk reduction in high-tech industries. They notice that the attitudes of all employees can affect innovation. The most important factors in this respect are organisational culture, trust and communication. Therefore, effective resource management is an important factor in the creation of innovation [114].

Comparing the above analyses of risk and innovation to the division of sectors into traditional and technologically advanced, it can be concluded that the former are less exposed to threats resulting from the unpredictable effects of innovation. They do not invest significant resources in projects with an undefined rate of return, which in the case of innovation may be characterised by a high amplitude and frequency of fluctuations typical for increased risk. Such a conclusion is confirmed, inter alia, by the studies by Bi et al. [115] conducted in a group of entities dealing with the low-carbon economy. They show that production enterprises operating in this area have a low and average risk of activity, while departments dealing with research and development must face a much higher level of risk of activity.

It is also worth adding that the increased risk in highly innovative industries also results from the significant involvement of capital in innovative ventures. In the event of failure, the enterprise may lose its liquidity, credibility and, as a result, even go bankrupt. Few traditional development investments generate such unpredictable and significant risks. It is also worth adding that currently the economic risk is intensified by the global crisis related to the COVID-19 pandemic and the war in Ukraine. This causes fluctuations in the capital markets, changes in interest rates and restrictions in access to capital [116].

The ambiguity of the results, including their geographical [117] and economic [118,119] dispersion, imply the need to deepen the study of the risks associated with innovation. It is particularly important in the regional and national perspective, due to the circumstances cited in the introduction, including significant differences in the level of innovation of individual economies. Therefore, in the further part of this article, the risk of running a business in traditional and high-tech industries—by definition those characterised by a high level of innovation, is subject to a comparative analysis and assessment.

An additional value of the research is the measurement of the risk related to innovation in connection with its ultimate effectiveness, which is rarely analysed in the context of the research conducted so far. The authors and researchers primarily focus on management aspects related to the perception and attitudes towards risk.

3. Methodology

3.1. Research Intentions and Problems

As already mentioned, this article examines the relationship between innovation in terms of industries and the risk of running a business in two groups of industries in the Polish economy. The first group includes 33 enterprises operating in traditional sectors, such as: chemical, fuel and energy, construction and trade and services. The second group includes 18 high-tech enterprises from the medical, pharmaceutical, telecommunications and IT sectors. All the surveyed enterprises are large companies listed on the Warsaw Stock Exchange. Their list is presented in Table 1, and the short characteristics of the conducted activity in Appendix A.

Table 1. List of enterprises included in the research.

Sector	Enterprise
Traditional enterprises	
CHEMISTRY AND COMMODITIES	BOGDANKA; CIECH; COGNOR; GRUPA AZOTY; JSW; KĘTY; KGHM; STALPRODUKT
FUEL AND ENERGY	ENEA; KOGENERACJA; LOTOS; PEP; PGE; PGNIG; PKN ORLEN; TAURON
INDUSTRIAL AND CONSTRUCTION PRODUCTION	APATOR; BUDIMEX; ERBUD; FAMUR; INSTAL; MANGATA; MIRBUD; POLIMEX MS; TRAKCJA; WIELTON
TRADE AND SERVICES	AB; ASBIS; CCC; EUROCASH; INTERCARS; LPP; VRG
High-tech enterprises	
HEALTHCARE	BIOMED LUBLIN; BIOTON; CORMAY; MABION; MEDICALGORITMICS; RYVU; VOXEL
IT and ICT	ASSECO POLAND; ASSECO SEE; CD PROJEKT; CI GAMES; COMARCH; COMP; CYFROWY POLSAT; NETIA; OPONEO.PL; ORANGE.PL; PGS SOFTWARE (Wrocław, Poland)

Source: own work.

The selection of enterprises for the research listed in Table 1 is justified by the following circumstances:

- the assumed division into traditional and high-tech industries;
- the structure of the Polish economy, dominated by traditional sectors, and within modern industries mainly telecommunications, healthcare and IT are developing (there are definitely fewer enterprises dealing with ecology and implementing eco-innovations, or they operate in the form of smaller enterprises);
- the availability of sufficiently long time series for the financial data included in the study to allow comparative statistical analysis.

Taking into account all the above assumptions and the research period covering the years 2008–2020 it allowed us to pick out 44 enterprises from among all listed companies shown in Table 1. The financial data used in the study come from the financial statements of the surveyed enterprises published in a uniform and synthetic form on the biznesradar.pl website.

The main goal of the research is a comparative analysis of the relationship between innovativeness and the risk of running a business in traditional and high-tech industries exemplified by the Polish economy. Additionally, in the course of the conducted analyses, answers to the following research problems are sought:

R1: Does a high level of innovativeness also mean a high level of risk for the enterprise?
R2: Are enterprises operating in innovative industries associated with a higher risk than enterprises operating in traditional industries?
R3: How can the risk accompanying innovation affect enterprises, sectors and the economy in Poland?

3.2. Business Risk Assessment Model in the Context of Corporate Innovativeness

Considering that the research focuses on the analysis of the relationship between innovativeness and business risk, the research model takes into account financial parameters that quantify the effects of both phenomena.

Thus, the results of high innovativeness in the short term are reflected in the financial result, in particular at the level of the sales result, which is shaped directly by revenues and costs in operating activities [120–123]. In the long term, the expected effect of high innovativeness should be the development of the enterprise expressed in financial terms by the value of assets and the rate of return on these assets [124–126].

Due to the above circumstances, the following parameters were used as the starting parameters in the business risk assessment model in the context of enterprise innovativeness: net financial result on sales, revenues from sales, total costs and operating costs and total assets. The above-mentioned variables were considered in absolute and relative terms with the use of ratios presented in Figure 1 and were relating to comparable and unified forms of defining productivity or efficiency.

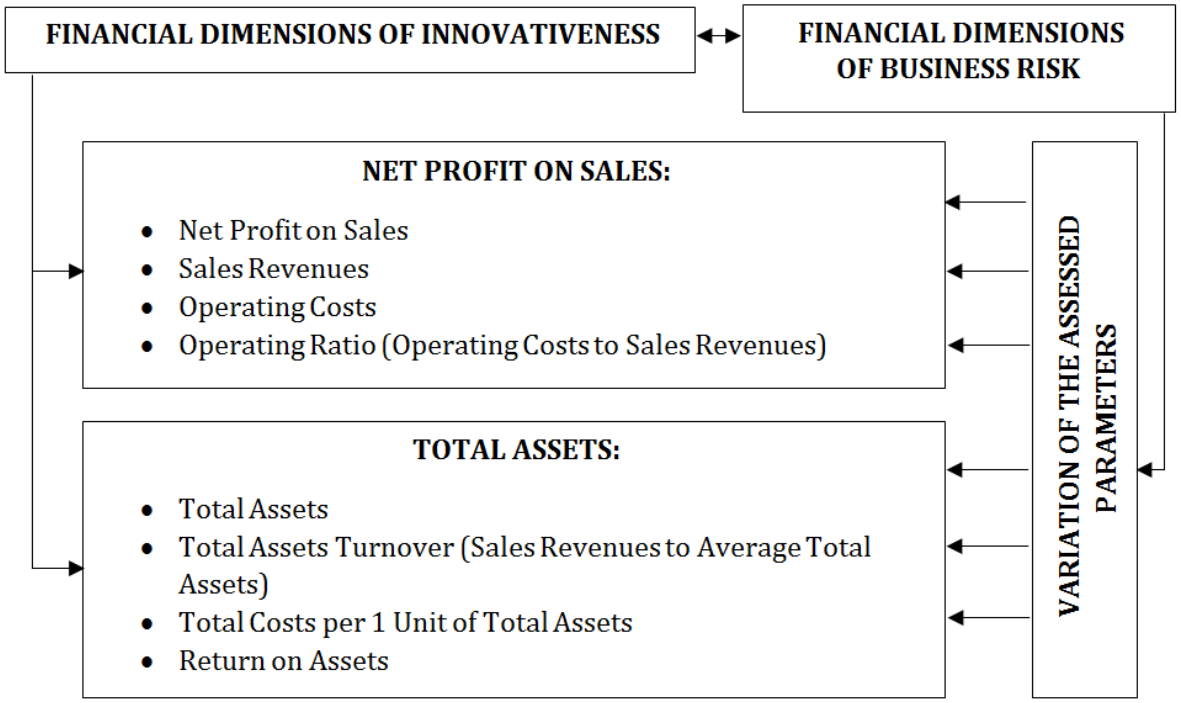

Figure 1. Business risk assessment model in the context of corporate innovativeness. Source: own work.

In the case of risk assessment, reference was made to its classical definition related to the variation of results of decisions/activities and the generally accepted assumption that the higher it is, the higher the risk of a given decision/activity. This variation was assessed separately

for each of the financial parameters listed in Figure 1 through the analysis in the 'expected value-risk' layout in relation to relative changes, i.e., percentage changes/growth rates:

$$GR_x = x_1/x_0 - 1 \tag{1}$$

To avoid misrepresentation of relative (percentage) changes, due to possible shifts from negative to negative or from negative to positive values, with respect to Net Profit from Sales and Return on Assets—two variants of the formula were used depending on the situation (assuming that $x_0 \neq 0$):

$$GR_x = \begin{cases} \frac{x_1}{x_0} - 1, \text{ when } x_0 > 0, \\ -\left(\frac{x_1}{x_0} - 1\right), \text{ when } x_0 < 0. \end{cases} \tag{2}$$

Due to the relatively short time scope of the analysis and significant dispersion within individual variables, the analysis in the 'expected value-risk' layout as a measure of the expected value of individual variables assumed a median:

$$Me = \begin{cases} x_{\frac{n+1}{2}}, \text{ when } n \text{ is odd}, \\ \frac{1}{2}\left(x_{\frac{n}{2}} + x_{\frac{n}{2}+1}\right), \text{ when } n \text{ is even}. \end{cases} \tag{3}$$

where:

Me—median, middle value of the sample,
n—the number of periods the data comes from,
x—a value of the variable from the given period.

On the other hand, the risk was assumed to be considered in general terms as a deviation from the expected value and determined based on a measure adequate for the median, i.e., a quartile deviation based on the interquartile range:

$$IQR = Q_3 - Q_1, \tag{4}$$

$$QD = \frac{IQR}{2} = \frac{Q_3 - Q_1}{2}, \tag{5}$$

where:

IQR—interquartile range,
Q_1—first quartile,
Q_3—third quartile,
QD—quartile deviation.

The above-mentioned measures can then be used to present the dispersion of the studied population (sample) by calculating so-called typical area of variation—*TAOV* (6):

$$TAOV: \ [Me - QD, \ Me + QD]. \tag{6}$$

The results of the comparisons are presented in graphical form in the aggregate charts.

4. Results

4.1. Business Risk Assessment in the Context of Innovativeness: The Financial Result Perspective

In the first part of the research, reference was made to the changes in the net financial result from sales and the variables determining its value. The assessment of changes in the result on sales in the surveyed enterprises is presented in Figures 2 and 3.

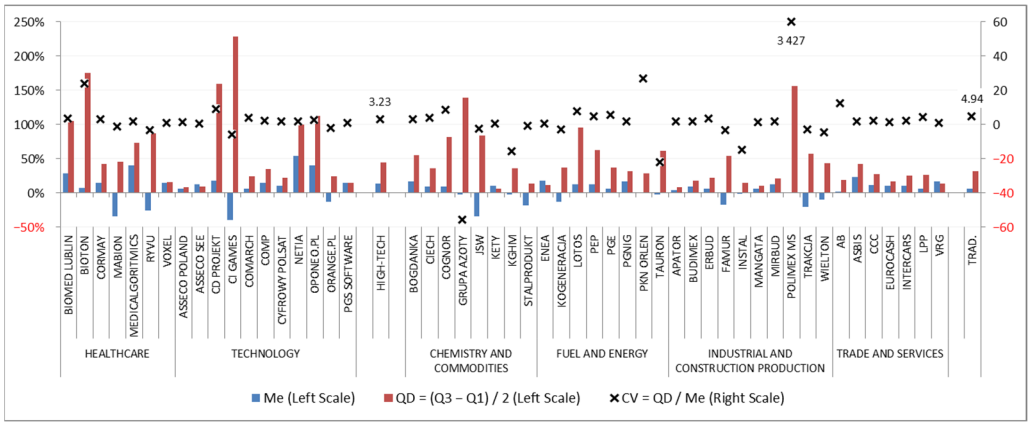

Figure 2. Assessment of changes in the result on sales in the surveyed enterprises. Source: own work.

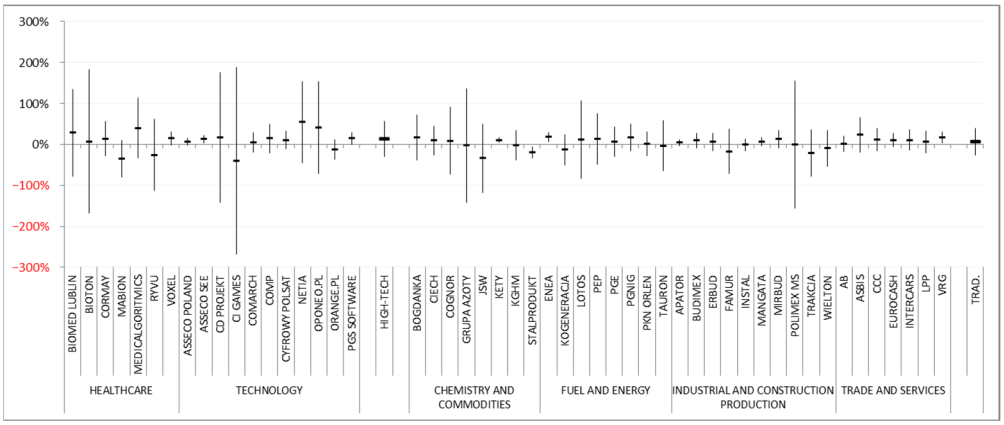

Figure 3. A typical area of variation of the result on sales in the surveyed enterprises. Source: own work.

The presented results show that high-tech enterprises had a generally higher value of median changes in net sales YoY, quarter deviations and a more extensive typical area of variation than enterprises operating in traditional sectors. This concerned in particular pharmaceutical enterprises (Biomed Lublin and Bioton), producers of computer games (CI Games and CD Project) as well as a telecommunications operator (Netia) and an Internet tyre site (Oponeo.pl). Nevertheless, it is worth noting that among the enterprises with high variation of the financial result on sales, there were also several entities with a traditional business profile, mainly Grupa Azoty (chemistry and commodities), Lotos (fuel and energy) and Polimex MS (industrial and construction production). At the same time, it should be noted that in terms of the coefficient of variation of the net result on sales, which notifies about the risk per unit of the expected value, enterprises from traditional sectors present themselves as slightly riskier, and at the same time less effective in the analysed case. In contrast to high-tech companies, a higher risk corresponds to relatively lower increases in the net result on sales YoY.

Due to the fact that the result on sales is influenced by two key factors, the further analysis took into account the variation of sales revenues and operating costs. First, the focus was on sales revenues, for which the results of the analysis are presented in Figures 4 and 5.

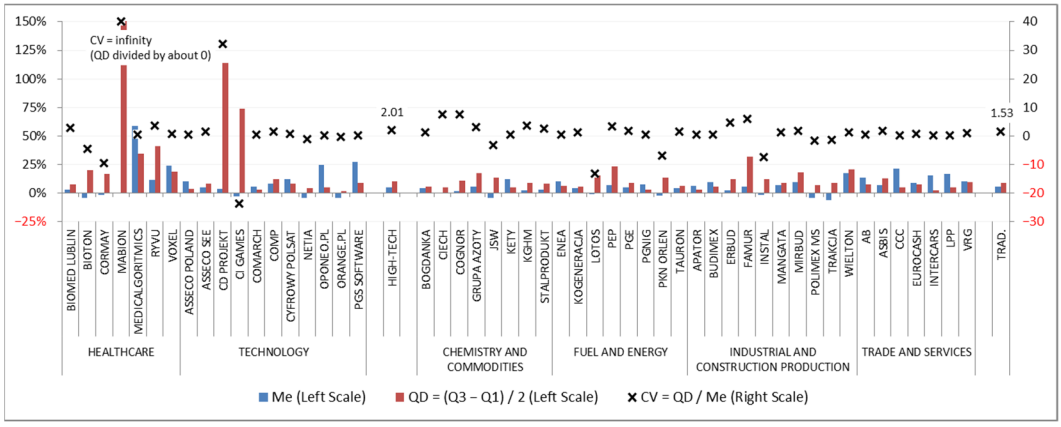

Figure 4. Assessment of changes in sales revenues in the surveyed enterprises. Source: own work.

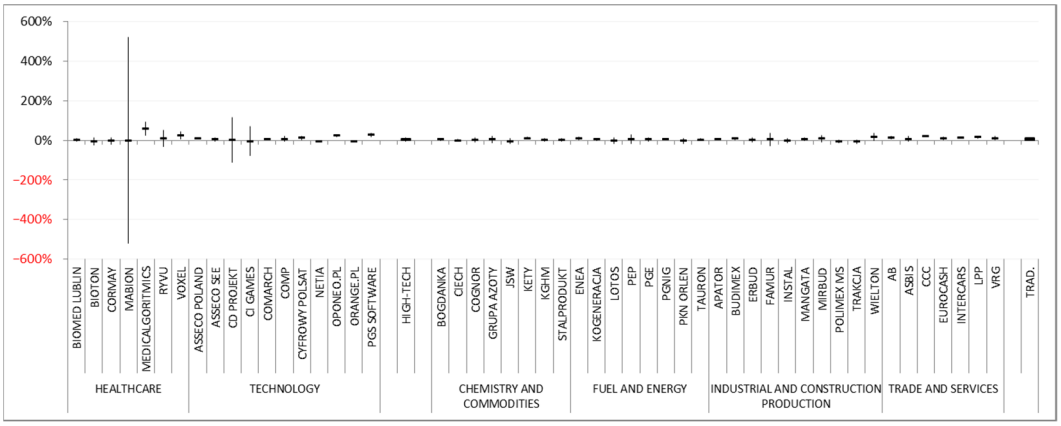

Figure 5. A typical area of variation of sales revenues in the surveyed enterprises. Source: own work.

In the case of revenues, the highest variation concerned Mabion—a producer of the latest generation of biotechnological medications based on humanised monoclonal antibodies. The variation of revenues, which stood out from other surveyed enterprises, was also characteristic of the computer games sector (CD Project and CI Games). In both cases, the high level of variation results from the cyclical nature of work on the technologies used (biological and computer), which in practice means a long period of incurring R&D expenditure and the accumulation of hard to predict revenues in several periods after the completion of work on a given medication or computer game. Considerable increases in revenues YoY, with no greater variation, also applied to such high-tech entities as Medicalgoritmics, Oponeo.pl and PGS Software. In the case of enterprises from traditional sectors, much lower expected values of revenue increases YoY, quarter deviations of revenues, variation ratios, and, consequently, typical ranges of variation with a smaller range were obtained.

When analysing the variation of operating costs (Figures 6 and 7), it should also be stated that the higher amplitude of fluctuations, and at the same time the higher risk, more often applied to enterprises operating in modern sectors of the economy.

High YoY changes in operating expenses, quarter deviations and a more extensive typical range of variation were recorded in the computer games sector (CD Projekt and CI Games) and in the healthcare sector (Mabion and Medicalgoritmics). Significant increases in operating costs YoY, with no greater variation, also applied to such high-tech entities as Ryvu, Oponeo.pl and PGS Software. In traditional sectors, the expected changes in operating costs and the quarter deviation were generally much lower. The only exceptions are Grupa Azoty (chemistry and commodities) and Famur and Wielton (industrial and construction production), and in the case of the growth itself—CCC (Trade and Services).

At the same time, as in the case of the risk analysis of the net result on sales, entities operating in traditional sectors present a higher risk in terms of the coefficient of variation.

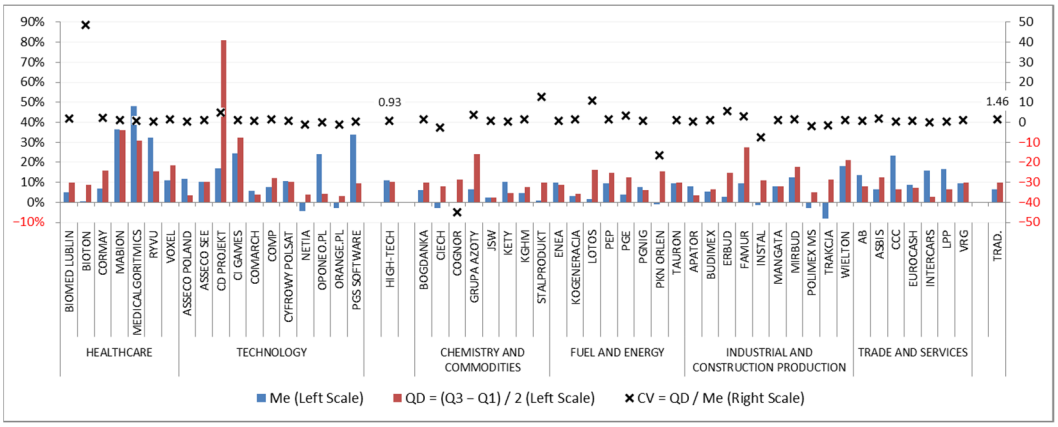

Figure 6. Assessment of changes in operating costs in the surveyed enterprises. Source: own work.

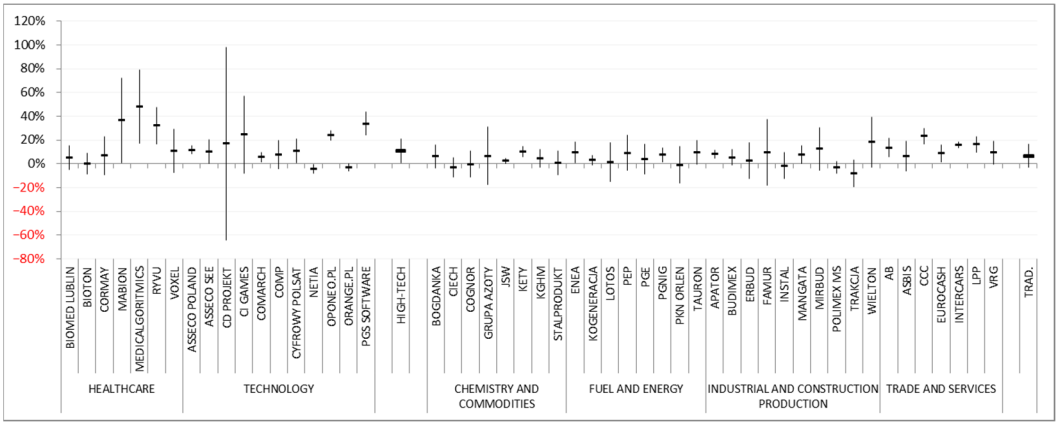

Figure 7. A typical area of variation of operating costs in the surveyed enterprises. Source: own work.

A specific summary of the risk analysis in the area of net result on sales are the results of the variation assessment of the operating cost level ratio—which is the ratio of operating costs to sales revenues—presented in Figures 8 and 9.

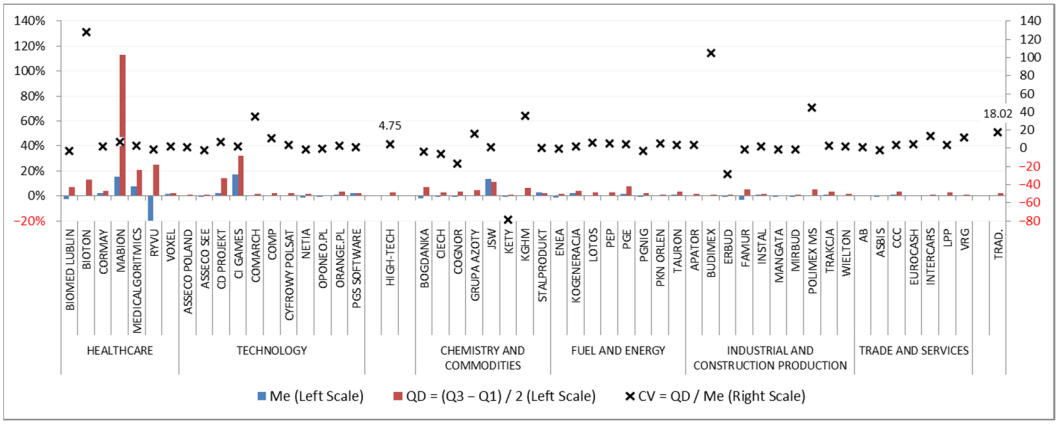

Figure 8. Assessment of changes in the operating cost level ratio in the surveyed enterprises. Source: own work.

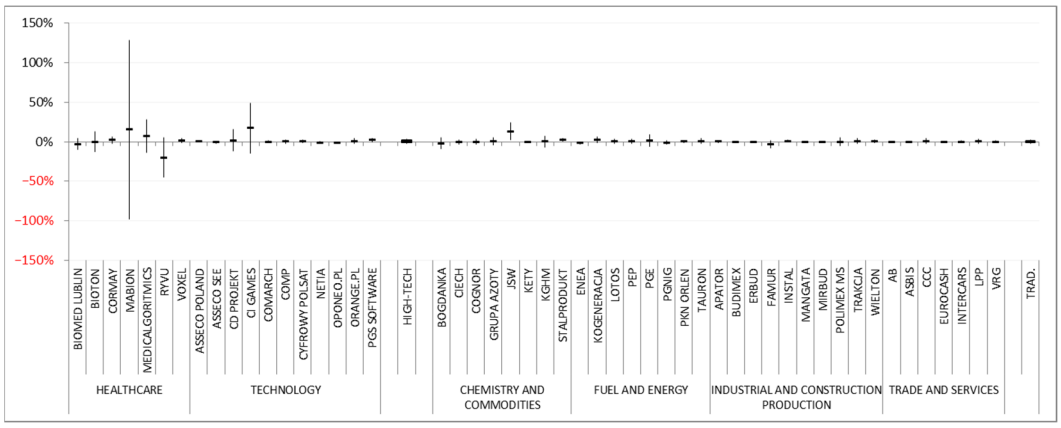

Figure 9. A typical area of variation of the operating cost level ratio in the surveyed enterprises. Source: own work.

Taking into account the obtained results, it can be concluded that the operating cost level ratio has a higher variation in high-tech industries, primarily in the healthcare sector and in the computer games sector, which results from the aforementioned uneven distribution of operating costs and sales revenues over time. The ratios of the coefficients of variation are somewhat contradictory to this interpretation, but they are not confirmed in typical areas of variation, which are clearly much wider in the case of high-tech companies. Thus, regardless of the reason for the described results, they confirm the high variation of the result on sales, and thus the high risk of doing business in these sectors and enterprises.

4.2. Business Risk Assessment in the Context of Innovativeness: The Asset Perspective

In the second part of the research, the assets of enterprises were referred to, treating their value as the foundation of enterprise development. Thus, Figures 10 and 11 present the results of the first stage of the analysis of total asset variation.

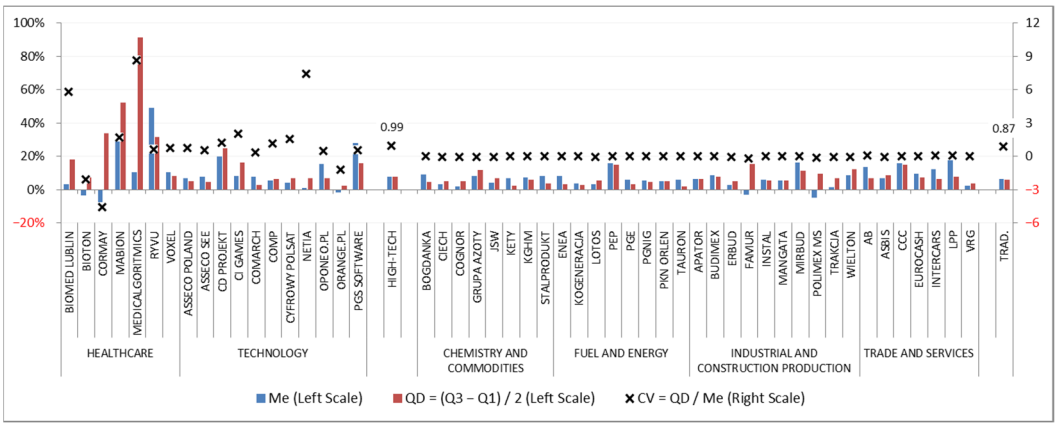

Figure 10. Assessment of total asset variation in the surveyed enterprises. Source: own work.

From the point of view of the measures used in the analysis, the highest risk of total asset variation is associated with the activities of enterprises from the healthcare sector (Medicalalgoritmics, Ryvu, Mabion, Cormay). In other industries, including both modern and traditional ones, the variation of assets is much lower, although it is worth paying attention to several companies from the technology sector (CD Projekt, CI Games, Oponeo.pl or PGS Software) and single cases of companies from traditional sectors (Grupa Azoty, PEP, Famur, CCC). Large fluctuations in the value of assets in the healthcare industry result from the high variation of the value of research and development costs, which are

recorded as an item of fixed assets until their completion, and only then, if the works are successful, are transferred to the financial result as tax deductible costs.

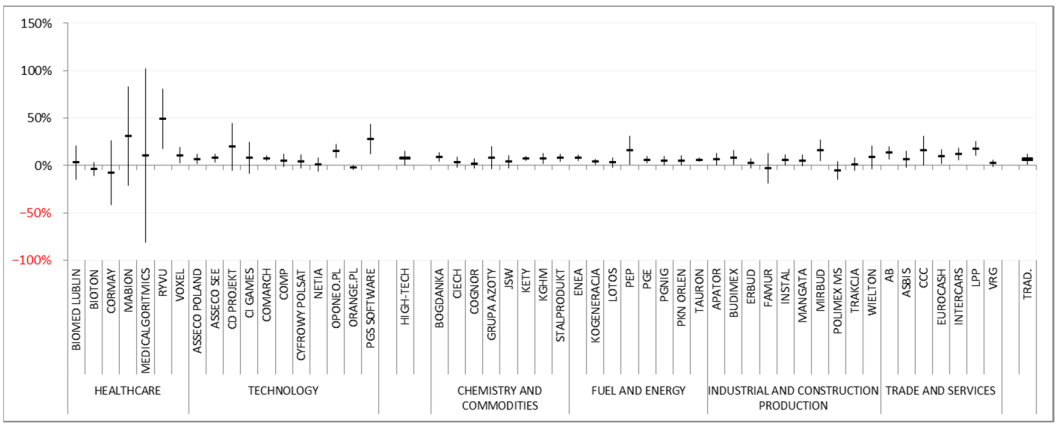

Figure 11. Typical area of total asset variation in the surveyed enterprises. Source: own work.

The subsequent stages of the asset analysis took place in relative terms. In the first step of this approach, the productivity of the assets of the surveyed enterprises was calculated, reflecting the value of sales revenues per unit of the assets used. Results of the calculation of the variation of this ratio are presented in Figures 12 and 13.

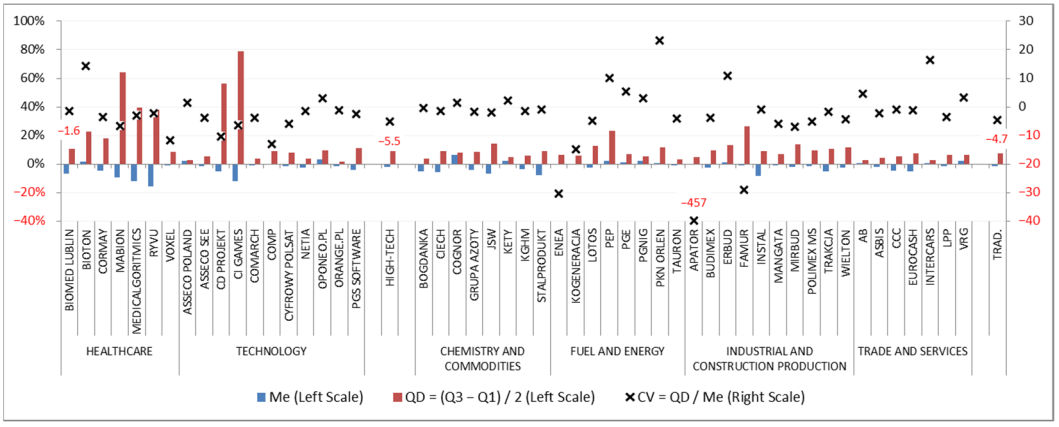

Figure 12. Assessment of the variation of asset productivity in the surveyed enterprises. Source: own work.

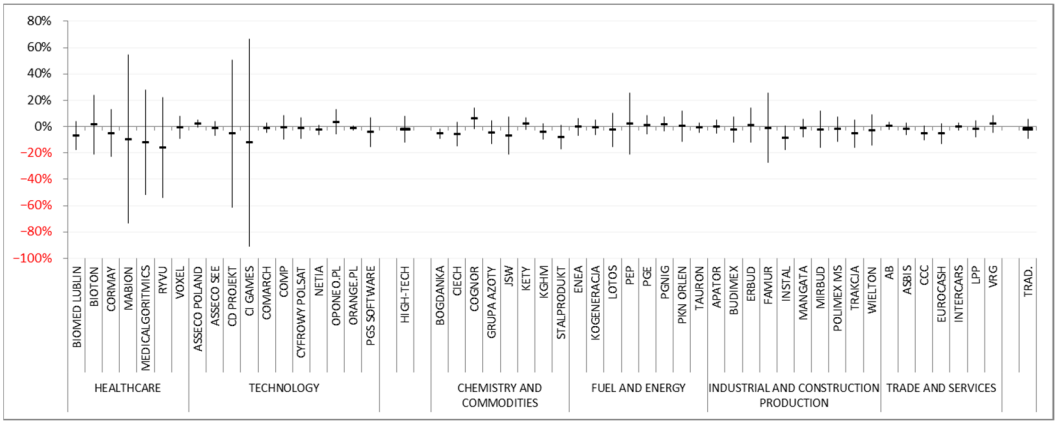

Figure 13. A typical area of variation in asset productivity in the surveyed enterprises. Source: own work.

In this research context, the highest variation and risk were again shown by high-tech enterprises, especially from the healthcare sector and the gaming industry. It is worth noting that for a relatively large group of enterprises with a traditional business profile, high values of the coefficients of variation were obtained, but they were not fully confirmed in the course of the analysis of a typical area of variation (such confirmation can only be said in relation to PEP and Famur).

The second step of the asset risk analysis focused on the total cost variation per unit of assets. Results of the assessment of this relationship are presented in Figures 14 and 15.

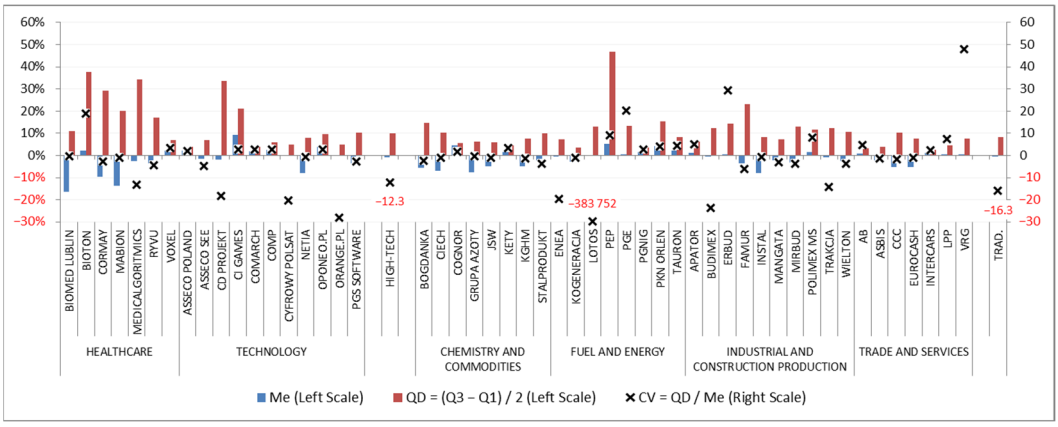

Figure 14. Assessment of total cost variation per unit of assets in the surveyed enterprises. Source: own work.

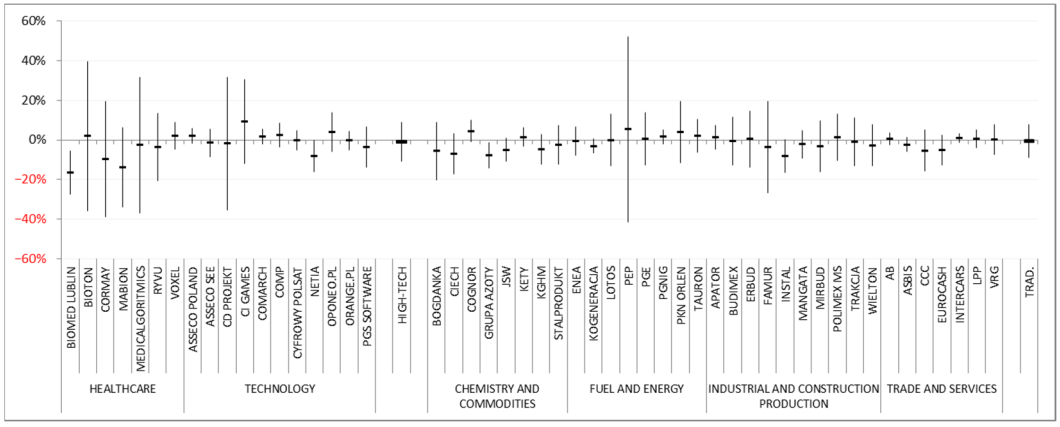

Figure 15. Typical area of total cost variation per unit of assets in the surveyed enterprises. Source: own work.

The obtained results indicate a slightly higher level of total cost variation per unit of assets in high-tech sectors. In the case of the median of changes, the quarter deviation and the typical area of variation, they indicated high variation and risk, especially in the healthcare sector and the computer games industry. In turn, in the case of traditional sectors, a relatively greater range of the typical area of variation could be observed in the industrial and construction production sector. Very high variation of costs per unit of assets also occurred in the PEP enterprises producing energy from conventional and renewable sources.

The analysis of the coefficients of variation for the described parameter indicates a high level of risk in several companies in most of the industries assessed, regardless of the general, definitional perception of sector innovation. The exception in this respect is the sector of chemistry and commodities and trade and services, where the coefficients of variation are at a similar, moderate level (the only exception is VRG).

The last of the analysed parameters was the rate of return on assets. Its variation is presented in Figures 16 and 17.

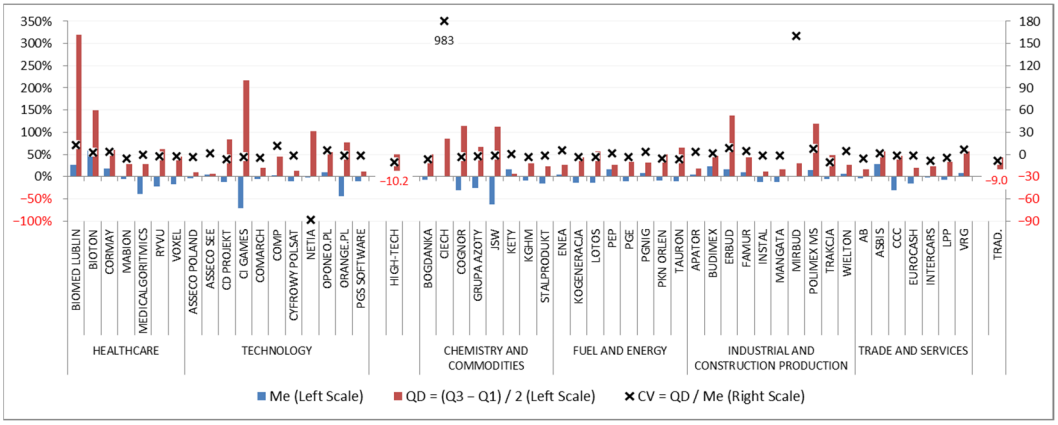

Figure 16. Assessment of the variation of the rate of return on assets in the surveyed enterprises. Source: own work.

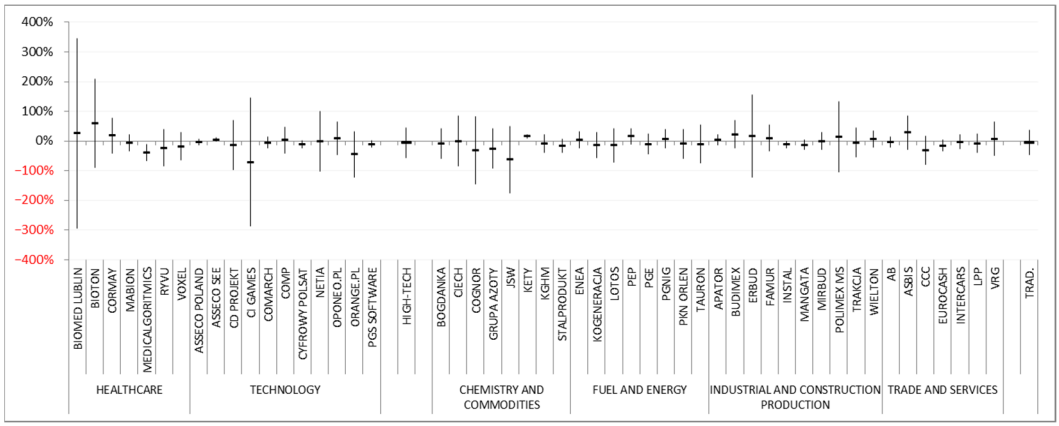

Figure 17. A typical area of variation of the rate of return on assets in the surveyed enterprises. Source: own work.

Taking into account the obtained results, it can be concluded that companies classified as high-tech sectors rather than traditional sectors have a slightly higher variation of the rate of return on assets (ROA). Due to large fluctuations in the financial result, ROA variation was the highest in healthcare and gaming companies. Among traditional sectors, higher risk in this respect was especially characteristic for entities from the chemistry and commodities sector as well as Erbud and Polimex companies belonging to the industrial and construction production sector.

4.3. Comparative Analysis of Risk in the Context of Innovativeness in High-Tech and Traditional Enterprises

In the last research stage, the data for individual enterprises presented in the two previous subchapters as aggregated to an 'average' assessment of individual sectors in all analysed areas. This operation was performed using the median for the Me and QD data, and then based on the obtained values, the CV and typical areas of variation were calculated. The results of this aggregation for the short-term perspective relating to the financial result on sales are shown in Figures 18 and 19, and the results for the long-term perspective relating to assets and growth are shown in Figures 20 and 21.

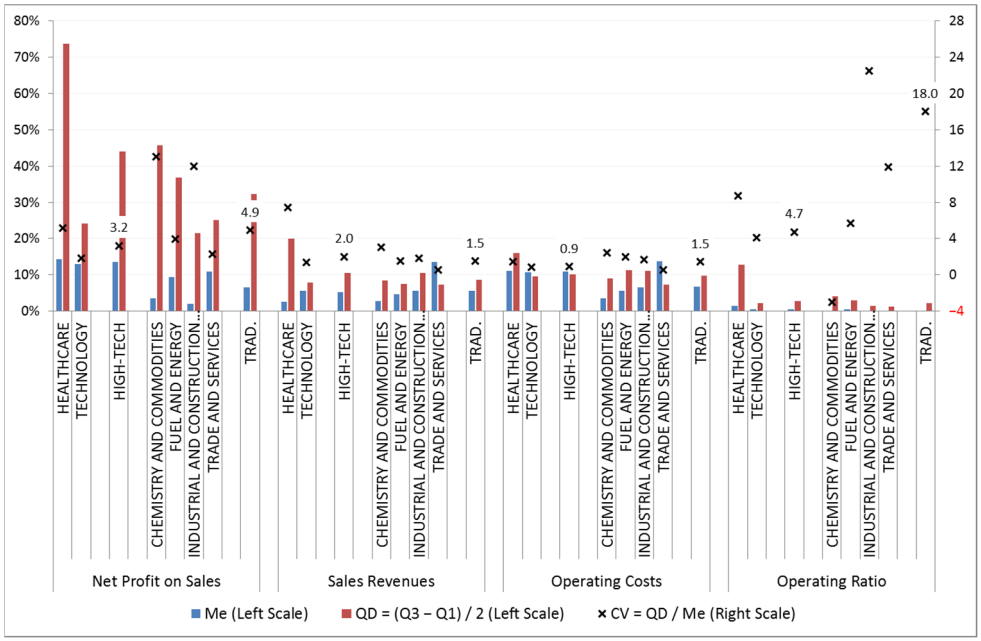

Figure 18. Assessment of variation in the area of result on sales in the analysed sectors. Source: own work.

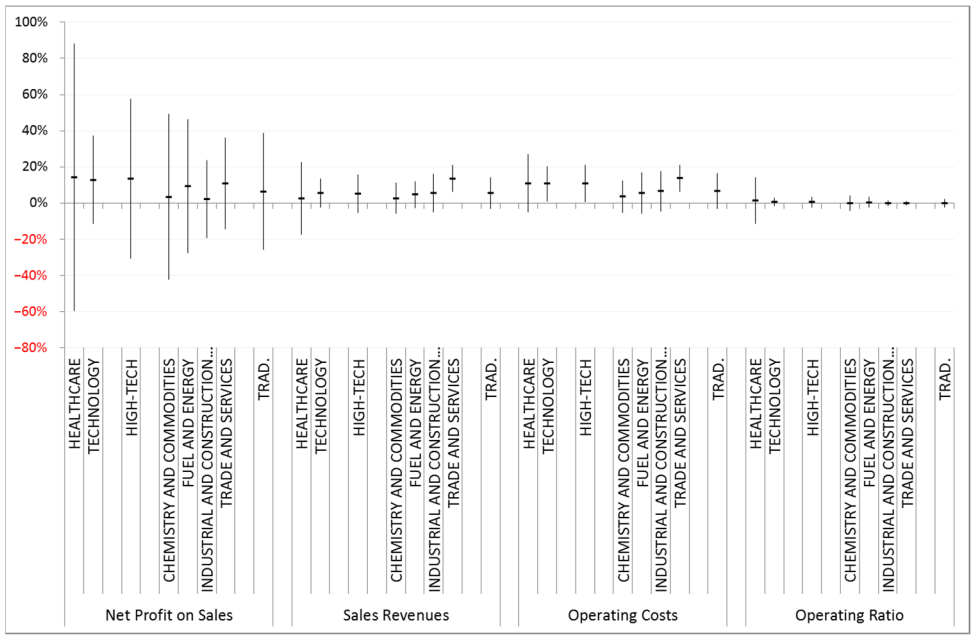

Figure 19. A typical area of variation in the area of result on sales in the analysed sectors. Source: own work.

Based on the presented data and analysis, the final conclusions presented in Table 2 were formulated, which are also a synthetic response to the research problems presented in the article. Additionally, the detailed results of the calculations are presented in Appendix B.

The information in Table 2 shows that industries considered innovative, regarded in the article as the high-tech group, had a higher level of risk (variation given by quartile deviation and typical area of variation) in the analysed areas than industries considered to be traditional.

In turn, the detailed conclusions indicate a very high level of variation and risk in the healthcare industry, in particular regarding enterprises producing modern medications and medicinal products. Moreover, in the high-tech group, high risk was also present in

the computer games sector. Due to the aggregation of data within the technology sector, this detail is not visible in the synthesis of the results, but the analysis of the data for individual enterprises clearly indicated such a tendency. In both cases, it is primarily the result of basing the enterprise's activity on product innovations built from scratch, but decisive for the enterprise's existence. In the financial results, this reflects the periodic, uneven incurring of costs (R&D) and obtaining revenues (after launching the product on the market).

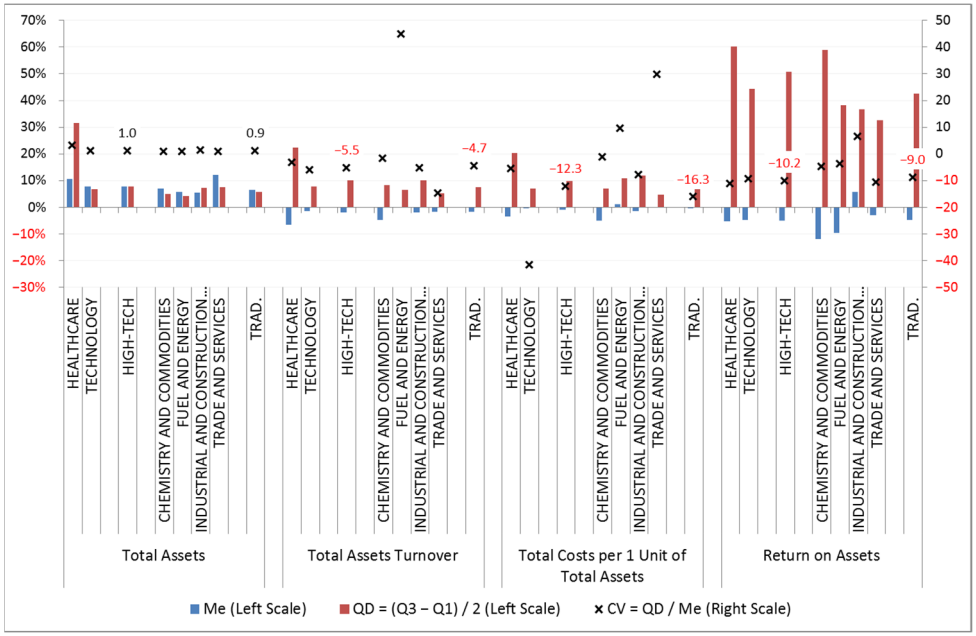

Figure 20. Assessment of variation in the area of assets in the analysed sectors. Source: own work.

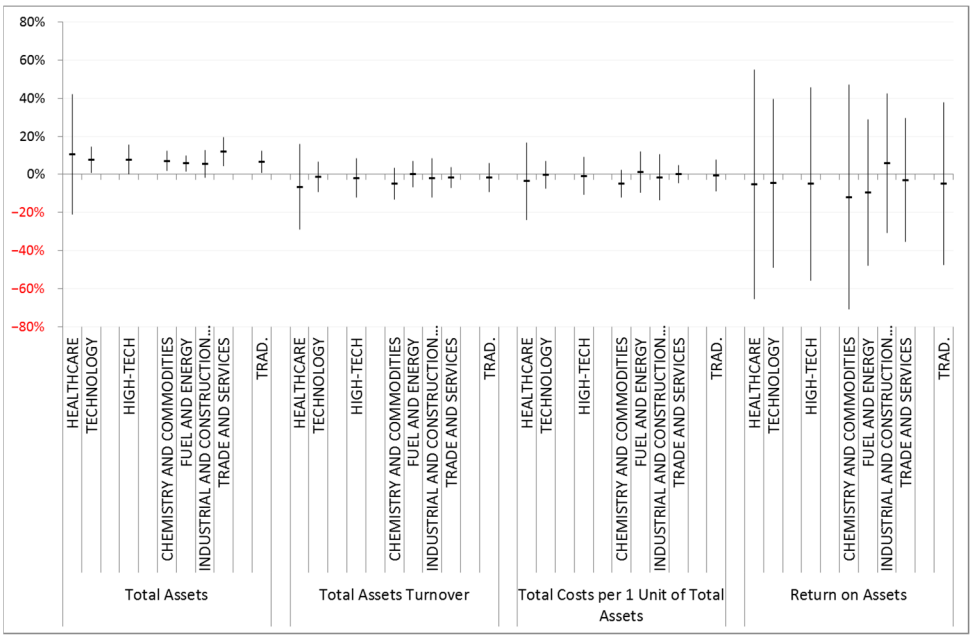

Figure 21. Typical area of variation in the area of assets in the analysed sectors. Source: own work.

Table 2. Comparison of the risks in different sectors and assessment areas.

Assessed Area	General Conclusions	Detailed Conclusions
Result on sales	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: chemistry and commodities
Sales revenues	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: industrial and construction production
Operation costs	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: fuel and energy; industrial and construction production
Cost level ratio	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: chemistry and commodities
Assets	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: trade and services
Asset productivity	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: industrial and construction production
Costs per unit of assets	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: industrial and construction production
Return on assets	Variation and higher risk in HIGH-TECH	Highest risk in HIGH-TECH: healthcare Highest risk in TRAD: chemistry and commodities

Source: own work.

In the group of traditional enterprises, the aggregate risk is lower than in the high-tech group. In individual areas of assessment, the highest variation most often occurs in the industrial and construction production sector (4 times), but high levels of risk were also noted in the case of chemistry and commodities and fuel and energy. Operating costs changed significantly in the fuel and energy sector. In the chemistry and commodities sector, high variation was seen in the result on sales, the operating expense ratio and return on assets. The observed trends most likely result from the unstable demand and supply situation in traditional industries. The high level of fixed costs (due to their capital intensity) is then not covered by sales revenues, strongly dependent on the economic situation and market competition.

5. Discussion

As indicated in the introduction, the innovativeness of any economy consists of many different elements and relationships that make up the national innovation network [26,27,74]. The quality and efficiency of the functioning of this network not only depend on the resultant position of a given country in international rankings, but also, perhaps even primarily, the level of income, prosperity and quality of life. For these reasons, the study of factors influencing innovativeness and that related to innovativeness should be considered extremely important from the theoretical and practical point of view [28–30,32].

As part of the analysis carried out in the article, it was noted that in the group of large listed enterprises responsible for creating innovations (high-tech) and present on the Polish market in the long term, there are mainly medical companies, including those producing modern pharmaceuticals. Therefore, their activity is mainly a response to demographic and social problems [69–71]. The high-tech group is complemented by telecommunications and IT enterprises, but in many cases, they are linked to international parent companies, which may not be conducive to generating primary innovations, but only support their transfer and diffusion.

In addition, large enterprises dealing with eco-innovations were not included in the studied group at all due to their limited number and short period of operation on the Polish market. Meanwhile, many of the studies cited at the beginning [61,64,65] show that they are currently one of the key conditions for the development of innovation at the national and individual level of enterprises. It is also worth emphasising that in Poland their activity and development would be particularly important and desirable due to the need for energy transformation, which, in light of the literature on the subject, is not possible without creating and implementing eco-innovation [57,58].

Attention should also be paid to the large share of the traditional sector in the studied group of enterprises, which is also not conducive to improving the innovativeness of the Polish economy. As shown in the research of Mahdavi Mazdeh et al. [77] enterprises with a traditional business profile are less likely to implement innovations on their own, and more often use ready-made solutions or outsource their development. In Poland, many of these enterprises are in decline, due to their connections with the closed hard coal mining industry, but they do not exclude the possibility of effective implementation of innovations, as indicated, inter alia, by the research results: [55,75,76].

Basically, the creation of innovation may also be discouraged by the high level of risk associated with this process, which is clearly confirmed by the results of the research carried out in this article. They are consistent with the previous considerations carried out, inter alia, by: [89–91]. It also seems that a very high level of risk in enterprises in the pharmaceutical industry results from the convergence of technological, market and financial risks raised in the literature [92–95]. The aforementioned enterprises must not only develop their main product from scratch, but also take the risk of not being classified in a very competitive market, as well as find capital providers willing to subsidize a very risky venture.

In light of the above, rational perception of risk and effective risk management are important in the development of innovation. It can support the innovation process at the enterprise level [87]. It can also encourage consumers to purchase innovative products and services [88]. In addition, the innovativeness of Polish traditional enterprises may support recruiting staff from high-tech enterprises. The exchange of knowledge and experience fosters creativity and entrepreneurship [113,114].

It follows from the above analyzes that greater complexity and advancement of innovation entail greater risk. In addition, higher risk also applies to product innovations. In less industrialized or service-offering sectors, the level of innovation risk is much lower. This confirms earlier literature conclusions relating to innovations in manufacturing and high technology sectors [96,97,99,100].

The conducted analyses also allow us to conclude that the sector of high-risk related to innovation is the computer games sector, currently considered to be one of the most strategic and prospective industries in the Polish economy. The relationships between risk and innovation in this industry have not yet been analysed in detail, and the observations made in this area suggest that attention should be focused on the special protection of this sector against risk from an individual and economic point of view.

Taking into account the results of the conducted research, to improve the innovativeness of Polish enterprises, in the long term, it would be necessary to improve the economic structure of enterprises and support enterprises and investments with a high degree of innovativeness, especially eco-innovations. In the short term and individual perspective, effective management of innovation risk could be useful, which means a comprehensive assessment of potential threats and planning methods for their mitigation, as emphasised in their research: [105–107].

Financial support is also an important aspect of the development of innovation. The government should offer entrepreneurs financial programs for research and development. It should also promote innovative solutions and highly innovative industries. The research conducted so far shows that it is an important determinant that reduces the risk associated with innovations [78–83].

In the development of innovativeness at the enterprise level, a particularly valuable instrument should be considered rewarding managers and teams that implement innovations effectively, because numerous analyses show that, first, they expect such remuneration, and second, its payment actually increases the level of innovativeness in enterprises [109,110]. It is also worth noting that if the high risk propensity among managers stimulates and strengthens innovativeness, then the selection of staff to conduct R&D works should take into account—apart from knowledge and experience—also this personality parameter [38,39,97].

6. Conclusions

6.1. Theoretical and Practical Implications

In Poland, in the group of large high-tech enterprises—by definition characterised by a high level of innovation—the medical industry is developing intensively, including in particular pharmaceutical companies producing new generation medications and the computer games industry. This group also includes producers of software for business and telecommunications companies. Nevertheless, the highest risk related to the implementation of innovations concerns the indicated pharmaceutical enterprises and producers of computer games. The above statement, based on the results of the analyses, allows for an affirmative answer to the first of the presented research problems. In light of the above, a higher level of innovation means a higher level of risk.

In the group of traditional enterprises dealing with production, the risk is more evenly distributed than in the case of high-tech companies, and it most intensely affects industrial and construction production, but the significant variation of the analysed financial parameters is also characteristic of such sectors as fuel and energy, chemistry and commodities. In trade and services, the risk is the lowest, and the studied parameters, com-pared to the high-tech group and the aforementioned traditional sectors, are characterised by very low variation. This may suggest a lower level of risk associated with the implementation of process, organisational and marketing innovations. The above observations also confirm the fact that in innovative sectors the risk is higher than in traditional sectors, which is an answer to the second research problem presented in the article.

In the context of the third research problem, it should be stated that the higher risk accompanying innovations complicates running a business. It means less predictability of the conditions and effects of this activity. This can discourage challenges and entrepreneurship, and consequently also limit the emergence of innovative companies and sectors. For the Polish economy, such a situation is not favourable, as it may be conducive to the maintenance of the present, non-modern economic structure. For these reasons, education, making people aware of the role and benefits of innovation and strengthening innovative attitudes is particularly important for Polish society and its future.

To strengthen the innovativeness of the Polish economy and the surveyed enterprises, and to reduce their exposure to risk, we recommend:

- raising awareness of the necessity of lifelong learning and the importance of innovation for social and civilisation development,
- supporting creativity and entrepreneurship at all levels of education and development,
- education in the field of risk management methods in enterprises,
- strengthening and promoting industries and enterprises that have the potential and achievements in the field of innovation,
- increasing the scale of financial aid for innovative entrepreneurs and enterprises,
- promoting Polish innovation in the country and in the world,
- using the best practices in risk management and innovation development, especially those related to developing economies,
- offering assistance to innovative enterprises in crisis.

The contribution of the authors of this article to the development of research on the relationship between risk and innovativeness includes the following aspects:

- formulation of a comprehensive, universal method of risk assessment related to innovative activities;
- conducting a comparative risk-innovation analysis for a group of high-tech and traditional enterprises;
- risk assessment within individual enterprises, industries and individual groups;
- the possibility of using research results both by decision-makers from the macro and mesoeconomic level of the innovation system, as well as by managers of the surveyed enterprises.

6.2. Research Limitations and Further Research

The limitation of these considerations and analyses is primarily their geographic scope, limited to the Polish economy. However, the formulated conclusions and recommendations can also be used in other emerging economies, including in particular those part of the groups of moderate and modest innovators in the European innovation ranking. Due to the universality of the presented risk assessment methodology, it can be practically carried out for every enterprise or group of enterprises.

An additional limitation of the research conducted may also be a certain mismatch in terms of sector representativeness between the Polish economy and the companies listed on the Warsaw Stock Exchange assumed as the subject of the research. This applies, inter alia, to the automotive sector, which in recent years has been one of the driving forces of the Polish economy, and is represented on the Warsaw Stock Exchange to a limited extent (in the research sample, Wielton and Intercars are the representatives of this sector in a broader sense). However, due to the entry of new entities onto the Warsaw Stock Exchange, this situation is gradually changing and in the long term, including subsequent studies, it can be expected that these mismatches will be reduced.

Moreover, the risk assessment was performed with the use of synthetic measures, such as the financial result on sales or the value of assets, which in practice may not only be shaped by the level of innovativeness. However, it should be emphasised that the surveyed enterprises operate in the same general economic conditions, and all innovations are aimed at maximising the parameters defined in this way.

Future research should be conducted in two directions. The first may include case studies developed for individual enterprises. Conducting them will help to better understand the nature of the risks accompanying innovations. The second may be related to industrial risk and the search for its impact on innovation in emerging economies.

Moreover, further research may also constitute a continuation of the analyzes presented in the article. They will then become the basis for comparisons over time and for long-term conclusions. The presented methodology is universal and therefore it can also be used in international analyzes in emerging and developing economies.

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Appendix A

Table A1. Characteristics of the surveyed enterprises.

No.	Enterprise	Business Description
		High-tech enterprises
Healthcare sector:		
1.	BIOMED LUBLIN	Manufacturer of medicinal preparations (prescription medications and OTC medications—over the counter), medical devices and laboratory reagents (used in biochemical and medical laboratories).
2.	BIOTON	Manufacturer and distributor of biotechnological products (recombinant human insulin) and generic medications (mainly antibiotics).
3.	CORMAY	Manufacturer of high-quality diagnostic reagents and distributor of world-class medical equipment.
4.	MABION	Manufacturer of targeted medications that selectively target cancer cells, ensuring better effectiveness and lower toxicity of the therapy.
5.	MEDICALGORITMICS	Provider of system and algorithmic solutions in cardiological diagnostics, in particular in the field of ECG signal analysis.
6.	RYVU	Manufacturer of medications primarily used in the field of oncology. Develops several projects in both the clinical and preclinical stages.
7.	VOXEL	Network of medical diagnostic centres that provide highly specialised services in the field of radiology and offer a comprehensive range of services and products related to the use of the latest technological achievements in medicine.
Technology sector:		
8.	ASSECO POLAND	Manufacturer of technologically advanced software for companies from key sectors of the economy.
9.	ASSECO SEE	Provider of proprietary software and IT services in Southeast Europe.
10.	CD PROJEKT	Game manufacturer as part of the CD Project Red development studio and their distributor through GOG.com.
11.	CI GAMES	Manufacturer and publisher of video games.
12.	COMARCH	Manufacturer of IT systems, including software, computer and network hardware, implementation, training and maintenance services.
13.	COMP	Technology company specialising in solutions in the field of IT security, network security and solutions dedicated to the trade and services market.
14.	CYFROWY POLSAT	Provider of comprehensive, integrated media and telecommunications services.
15.	NETIA	Provides wired telephone services, voice telecommunications services, data transmission services, television services, mobile telephony and broadband Internet access
16.	OPONEO.PL	The company sells tires and rims online. Currently, leading the tire industry in the country, also has over a dozen foreign shops in Europe and the USA.
17.	ORANGE.PL	Leading provider of telecommunications services in Poland and Central and Eastern Europe.
18.	PGS SOFTWARE	IT company offering services in the field of software development and IT outsourcing. Customers are mainly foreign companies, mainly from Great Britain, Scandinavian countries and Germany.
		Traditional enterprises
Chemistry and commodities sector:		
19.	BOGDANKA	Hard coal manufacturer in Poland, standing out from the industry in terms of hard coal mining efficiency and investment plans.
20.	CIECH	Production, trade and distribution of chemicals.
21.	COGNOR	Operates in two main areas: production of semi-finished products and steel products.
22.	GRUPA AZOTY	One of the key concerns in the fertiliser and chemical industry in Europe.
23.	JSW	Largest manufacturer of high-quality type 35 (hard) coking coal and a significant manufacturer of coke in the European Union.
24.	KĘTY	Production and sale of aluminum profiles and components, aluminum systems used in the construction industry, flexible packaging and polypropylene films.

Table A1. *Cont.*

No.	Enterprise	Business Description
25.	KGHM	Leading European concern extracting copper ore and non-ferrous metals.
26.	STALPRODUKT	Manufacturer and exporter of highly processed steel products: electrical transformer sheets, cold bent sections, road barriers and toroidal cores.
Fuel and energy sector:		
27.	ENEA	Manufacturer and distributor of electricity and heat.
28.	KOGENERACJA	Manufacturer of electricity and heat generated in cogeneration.
29.	LOTOS	Oil company dealing in the extraction and processing of crude oil as well as wholesale and retail sale of petroleum products.
30.	PEP	Implementation of projects in the energy sector, ranging from the production of electricity from conventional and renewable sources, through the distribution of electricity and gas, to the sale and trade of energy and certificates of origin.
31.	PGE	Lignite mining, electricity generation from fossil fuels and renewable energy sources, distribution and sale of electricity to end users.
32.	PGNIG	Exploration and operation of natural gas and crude oil as well as import, storage, trade and distribution of gaseous and liquid fuels.
33.	PKN ORLEN	Manufacturer and distributor of petroleum and petrochemical products.
34.	TAURON	Distributor, seller and manufacturer of electricity.
Industrial and construction production sector:		
35.	APATOR	Manufacturer of measuring equipment and systems, as well as suppliers of modern solutions for the automation of electricity grid operation.
36.	BUDIMEX	Offers services (most often as a general contractor) in the following infrastructure sectors: road, rail, airport, building construction, energy, industrial and ecological.
37.	ERBUD	Business activity is carried out in general contracting in the following segments: cubature construction, road and engineering construction, industrial construction and engineering and service for the energy sector, as well as in the development segment.
38.	FAMUR	Manufacturer of mining machinery and equipment (including mechanised longwall systems, systems for drilling drifts, underground transport systems and machines for open-pit mining).
39.	INSTAL	Provides construction and assembly services in the field of industrial and construction installations, production of installation elements and steel structures as well as design, production and assembly of ventilation and air conditioning systems.
40.	MANGATA	Industrial holding conducting business in 3 operating segments: automotive, fittings and industrial automation, fasteners. Group of companies distributing products to over 70 countries around the world.
41.	MIRBUD	General contractor in the field of public utility, residential, industrial and road engineering.
42.	POLIMEX MS	Engineering and service business.
43.	TRAKCJA	Implementation of works related to the broadly understood rail and road infrastructure with the use of a modern machine park.
44.	WIELTON	Manufacturer and seller of semi-trailers and trailers, as well as bodies for trucks.
Trade and services sector:		
45.	AB	The largest distribution network in the CEE region selling products of the world's largest producers of modern technologies.
46.	ASBIS	One of the leading distributors of information technology products in the emerging markets of Europe, the Middle East and Africa.
47.	CCC	The largest footwear retail company in Central Europe and the largest footwear manufacturer in Europe.
48.	EUROCASH	A leader in the wholesale distribution of FMCG products on the Polish market.
49.	INTERCARS	The largest importer and distributor of spare parts for passenger cars and commercial vehicles.
50.	LPP	A company that designs and distributes clothing in Poland and abroad. The brands offered by LPP differ in terms of target groups. It offers clothes for children (RE Kids brand, part of the RESERVED brand), teenagers (Cropp, House, SiNSAY) and adults (MOHITO, RESERVED and Tallinder).
51.	VRG	The Group specialises in designing and distributing high-quality fashion collections for men and women as well as jewelery. It is the owner of trademarks in five main lines: Vistula, Bytom, Wólczanka, Deni Cler Milano and W.KRUK.

Appendix B

Table A2. Detailed calculation results.

	Me	QD = (Q3 − Q1)/2	Me − QD	Me + QD
		Net Profit on Sales		
HEALTHCARE	14%	74%	−59%	88%
TECHNOLOGY	13%	24%	−11%	37%
HIGH-TECH	14%	44%	−30%	58%
CHEMISTRY AND COMMODITIES	3%	46%	−42%	49%
FUEL AND ENERGY	9%	37%	−28%	46%
INDUSTRIAL AND CONSTRUCTION PRODUCTION	2%	22%	−19%	24%
TRADE AND SERVICES	11%	25%	−14%	36%
TRAD.	7%	32%	−26%	39%
		Sales Revenues		
HEALTHCARE	3%	20%	−17%	23%
TECHNOLOGY	6%	8%	−2%	14%
HIGH-TECH	5%	10%	−5%	16%
CHEMISTRY AND COMMODITIES	3%	8%	−6%	11%
FUEL AND ENERGY	5%	7%	−3%	12%
INDUSTRIAL AND CONSTRUCTION PRODUCTION	6%	11%	−5%	16%
TRADE AND SERVICES	14%	7%	6%	21%
TRAD.	6%	9%	−3%	14%
		Operating Costs		
HEALTHCARE	11%	16%	−5%	27%
TECHNOLOGY	11%	10%	1%	20%
HIGH-TECH	11%	10%	1%	21%
CHEMISTRY AND COMMODITIES	4%	9%	−5%	13%
FUEL AND ENERGY	6%	11%	−6%	17%
INDUSTRIAL AND CONSTRUCTION PRODUCTION	7%	11%	−5%	18%
TRADE AND SERVICES	14%	7%	6%	21%
TRAD.	7%	10%	−3%	16%
		Operating Ratio		
HEALTHCARE	1%	13%	−11%	14%
TECHNOLOGY	1%	2%	−2%	3%
HIGH-TECH	1%	3%	−2%	3%
CHEMISTRY AND COMMODITIES	0%	4%	−4%	4%
FUEL AND ENERGY	1%	3%	−2%	3%
INDUSTRIAL AND CONSTRUCTION PRODUCTION	0%	1%	−1%	1%
TRADE AND SERVICES	0%	1%	−1%	1%
TRAD.	0%	2%	−2%	2%

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