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Determinants of Sustainable Innovation Expansion Strategy: the Case Study of Companies from a Declining Industry

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Abstract

Stimulation and improvement of innovative development is an extremely important component of economic growth in an economy, along with the companies' competitiveness in stagnating industries, which is especially relevant for companies at the maturity stage of the life cycle, where the risk of transition to the decline stage is highest. Without new developments and a sustainable innovation strategy, a company loses its leading position in the industry and misses new opportunities, leading it to the stage of stability and decline. Thus, it is important to study the factors that contribute to R&D intensity and encourage innovations in detail. This study investigates the impact of high level and quality of companies' patent activity on their financial potential in order to maintain stable innovation performance in the medium term. The sample comprises companies from the printer and camera sector between 2007 and 2020. The determinants of innovation expansion that characterize the technological readiness and market potential of firms to maintain their leading position in a highly competitive market are identified, using a case study method using the example of Canon and its competitor Xerox. The data are collected from Bloomberg and Orbis Patent Database. The results show that while high innovation activity is an important driver of growth, it does not always lead to better financial performance in the earlier stages of the life cycle. The study contributes to the literature by examining different characteristics of innovation activity and life cycle stages through the lens of external economic changes, which brings transparency and clarity in understanding the possible problems that may result from using already disclosed innovations of competitors as well as disclosing one's own intellectual property rights. The study proves that the greatest effect of innovation activity is observed in companies whose R&D expenditures are close to the industry average values along with diversification of revenue. The results of the study can help policy makers, managers and shareholders to build effective corporate governance to achieve strategic goals and minimize the risks of making wrong management decisions in R&D investments.

Keywords: life cycle, R&D, innovation intensity, investments, financial performance

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Introduction

The market for printing devices continues to transform, with a huge variety of document management systems and multifunctional devices (hereinafter referred to as MFPs) on the market in 2021, but their compatibility is a pressing issue. The need for simultaneous access from several users to the same device functions, taking into account the correctness of their fulfillment remains an urgent task in supporting the innovative development of MFPs [1], laser printing equipment and inkjet products. The acquisition of printing equipment is driven by the systematic replacement of end-of-life and obsolete devices, and as a result, like any dynamic business, printing and copying companies are interested in IT transformation to further improve customer service, accelerate business processes, and drive innovation. Successful innovators quickly adapt to the new reality. Setting qualitatively new goals and prioritizing all key areas of innovation, taking into account the long-term horizon when selecting strategy, allocating investments, and planning are all important factors of companies' success in the modern world. The relevance of the research question is related to the prospects for the development of companies in the R&D sphere. This is confirmed by the study of E. Naumova and G. Silkin, whose paper examines inclusive growth practices used in metallurgical companies and assesses their impact on financial results and value. An analysis of data showed that diversification of innovation directions has a positive impact on its financial results and value [2]. Utilizing all opportunities to take into account the latest achievements in related industries, as well as using the already disclosed innovations of competitors and disclosing their own intellectual property rights by formalizing their claims accordingly allows mature companies to maintain a position of leadership in innovation. As a result, those companies in the maturity stage whose citation rate is higher than the industry average [3], as well as those companies that are interested in innovative development, are more resistant to external economic changes and can maintain their potential for a long time.

In the context of economic crises, as well as unstable situations in the industry, companies show similarities and differences in their reactions to innovative development, while reducing or increasing flows from investment activities [4]. Against this backdrop, some companies improve the quality of financing while reducing investment, while others increase investment in the face of economic downturns. For example, D. Podukhovich in his study "CEO Investment Horizon Problem and Possible Ways to Solve It" notes that companies, that tend to make short-term investments have lower economic fundamentals and performance results performance [5]. As a consequence, counterintuitive actions may contribute to different events in the short and long term, leaving some or other consequences for firms. In order to identify the impact of a company's innovation activity on its future economic potential, it is necessary to consider its activities at different stages of the life cycle, including in the short and long term. To answer the research question posed, it is necessary to consider this problem using a case study, which focuses on the following factors:

- Historical analysis of financial performance;
- Patent activity of companies at different life cycle stages;
- Innovation activity of companies at the maturity stage;
- Methodological research aimed at identifying economic potential in companies;
- Analysis of non-financial metrics of Canon and Xerox.

Innovation is necessary for economic growth and development in a globalized economy. In order to consider a certain effect of innovation, it is necessary to trace the dynamics and all stages of the print industry formation using the example of specific companies [6].

Such authors as S. Gyedu et al., L. Fuentelsaz et al., M. Bianconi and C. Tan analyzed companies based not only on the difference in the performance of companies before and after any market events, but also on their effectiveness in achieving their goals. Suppose that a company increases the output of technologies that have been developed throughout the company life cycle, and in the future the investment is expected to generate a certain return over a certain period. However, how many companies have managed to achieve this, and are the selected companies performing better in the face of rapidly changing realities? Are the achieved results sustainable? These are the questions the authors answer in their research [7–9]. These papers contribute new evidence to the studies of corporate cash holding, focusing specifically on innovative companies. However, there are many research gaps in these papers, which are related to the lack of analysis of non-financial and innovation metrics, industry specifics, and the rather significant Life Cycle Stage indicator

The main purpose of this paper is to examine how innovation activity affects companies in a stagnant industry. In a growing industry high innovation activity has a positive effect on revenue, but whether it can stop the decline in revenue and help a company to grow further in an industry that has been in decline for over 5 years is a relevant question at the moment. This theory was tested by M. Zarva using the panel regression method. They selected about 3000 innovative companies of growing industry, as the GDP growth rate increased, the cash ratio of innovative companies decreased. The authors also reveal the insignificance of R&D expenditures for innovative companies and prove that ranking companies by the R&D expenditure amount and using this variable as innovation proxy was inexpedient [10].

Also, this paper raises the question of how the intensity of innovation and patent creation affects the ability of companies to stay in earlier stages without transitioning to the aging stage. In order to identify the relationship of innovation activity at different stages of the LCA, Apple was analyzed, which had a significant negative impact on the industry

with Canon and Xerox. Apple has been in the growth stage for a long time, and as a result, it is scientifically interesting to study how the company has been able to change its R&D expenditure policy in other stages and also in comparison to companies in a stagnant industry.

Literature Review and Development

Research issue

In order to maintain the current stage of the life cycle, a company must constantly work to improve its operations, adapt to changing market conditions and be ready for innovation. Innovation is a key factor in the development of the company that ensures its competitiveness in the market. The novelty of this study is that different innovation practices were analyzed simultaneously, and Canon's innovation expansion strategy was proven to be sustainable in the long term. However, the greatest effect of innovation activity is observed for those companies whose R&D expenditure was close to the industry average and was not inflated, while maintaining high quality and a relatively low number of patents. The advantage of these companies over their competitors is primarily inherent in the ability to move from the maturity stage to the growth stage, contributing to the decision to further increase economic potential and strengthen market position, which is the novelty of this research paper [11; 12]. This trend to improve business processes is addressed by A. Santos in her case study in order to improve the efficiency of the company's operations. The author's results clearly show the company's ability to achieve planned goals and the sustainability of the results achieved in the process of innovative development [13].

Innovative development promotes the creation of conditions and activities aimed at stimulating and supporting innovative processes in the economy and society. This may include financing scientific research, creating incubators and gas pedals for start-ups, organizing conferences and exhibitions, conducting courses and trainings on innovation and technology, and establishing legal and organizational frameworks for innovation activities. Promoting innovative development helps to increase the competitiveness of the economy, improve the quality of life of people and solve social and environmental problems. This is evidenced by S. Kwon and A. Marco in their study "Can antitrust law enforcement spur innovation? Antitrust regulation of patent consolidation and its impact on follow-on innovations", where with the case of the US Department of Justice's regulation of Novell's software patent transfers to four large proprietary software companies (i.e., Microsoft, Oracle, EMC, and Apple) in 2011. The paper confirms the fact that patent consolidation by patent transfer can restrict access to upstream technology and is thus a deterrent to monopolistic market power. The analyses using patent citation, copyright, and trademark data show the positive effect of the antitrust regulation of Novell's patent transfers on the development of follow-on software innovations by the patent-consolidating firms' competitors [14].

The main objects of the study are Xerox and Canon companies. Canon and Xerox image processing systems use technologies developed throughout the history of the development in companies. These are foundational technologies that are still used in all of Canon's current devices however, once the company began supplying its low-cost products to the U.S. market, Xerox was displaced from its first place as the leader in copying technology. The supply of Xerox devices continues to narrow, and the selection of devices themselves is limited to entry-level models that haven't been improved in a long time [15–17]. From a technological point of view, modern fax machines, replacing analog, are the same MFPs, as well as devices that allow you to connect to computers, are also inferior in their performance, quality of printing and scanning. As a result, the use of such devices manufactured by Xerox in the role of printer or printing is possible, but not optimal in pragmatic terms. Given the decline in demand, due to the lack of new promising areas of development, as well as the inability to adapt to the new market realities throughout all life cycles stages have prompted companies such as Xerox and Canon to restructure their businesses. This raises the need for comparative analysis at different life cycles of companies, where M. Cucculelli and V. Peruzzi conduct this assessment in their paper "Innovation over the industry life-cycle. Does ownership matter?" [18]. The case method confirms the fact that companies focus on product-oriented innovation during the growth stage of the industry life-cycle, and on process-oriented innovation during the maturity stage. This paper identifies different economic potential and innovation intensity at the growth and maturity life cycle stages.

Innovation activity

In this study, different innovation parameters were used. In addition to innovation intensity (ratio of R&D to revenue) and patent creation, indicators such as innovation efficiency (ratio of patents to R&D) and patent citation were used [19].

Expenditures on qualitatively new patents developed by companies mostly contribute to the accumulation of competencies to form a platform for further development. Systemic work with innovations requires the adjustment of the operating model, including the improvement of the organizational structure, tools and resources to ensure the necessary speed and flexibility in their implementation.

Innovation is essential for sustainable growth and economic development of both individual firms and industries, therefore, the relationship between economic growth and innovation is of great interest to researchers. Innovation measures such as R&D expenditures, R&D to revenue ratio, patents and trademarks can be found in various literature sources. For example, in the 2021 study "The impact of innovation on economic growth among G7 and BRICS countries", a group of scholars used R&D expenditures as an innovation measure. The paper examined the impact of R&D per capita in BRICS countries. The results showed that R&D expenditures increase the level of innovation and the latter leads to a constant growth in GDP per capita. The results suggest that innovation has a positive impact on GDP per capita for both developed and developing countries.

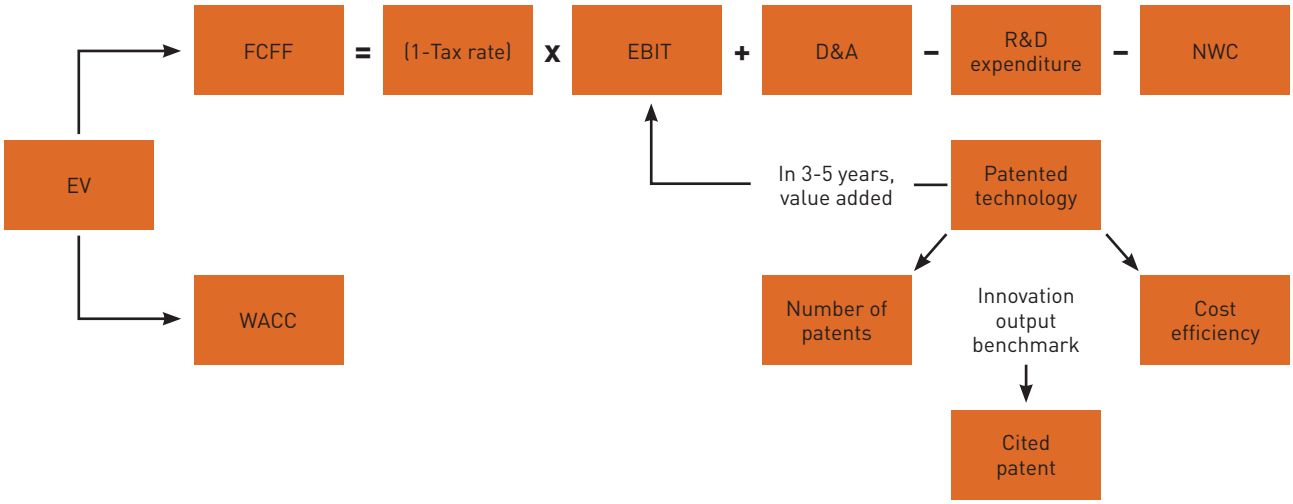
Innovation policy should take into account the complexity of the economic growth process, including indicators other than R&D expenditures. Thus, in the work of G. Valacchi et al. [20] entitled "Impact of outward foreign direct investments on patent activity of Greenfield multinationals" the number of patents is used as innovation, and in the study of S. Ling et al. "The Effects of Financing Channels on Enterprise Innovation and Life Cycle in Chinese A-Share Listed Companies: An Empirical Analysis" uses the ratio of R&D to revenue [21]. In the study of T. Tang "Hedge fund activism and corporate innovation" companies were classified into different cash flow-based LCRs, and the main financing channels were analyzed [22]. As a result, it was determined that government subsidies, tax preferences, equity financing and equity financing can significantly stimulate innovation of company activities, while bank loans can significantly restrain their innovation development. Financing channels have a non-linear relationship (U-shape) with firms' innovation, and the life cycle has a moderating effect on the incentive effect of innovation financing channels, subsequently, the incentive effect of financing channels represented by government subsidies and tax incentives weakens with the advancement of life cycle stages [23].

In the paper "Do the innovative MNEs generate added value in emerging economy?" [24] researchers such as P. Szklarz et al. investigated the impact of innovation on the competitiveness and profitability of a company. The dependent variables were such indicators as EVA, EV, ROA and ROE. The explanatory variable was R&D expenditures in different sectors of the economy. The results of the study revealed that companies from developed economies with a strong innovation base achieve a higher return on invested capital than companies from emerging economies. As a consequence, the companies described demonstrate better financial performance, as well as generate higher economic profits and receive sufficient financial incentive for further innovation.

Researchers point out that during the growth stage, unstable consumer preferences and rising demand continue to drive the intensity of product innovation. During the transition to the maturity stage, products become more standardized and companies compete on performance or efficiency. Innovation in product solutions is replaced by innovation in firm processes, focusing on managerial best practices that are investigated by N. Bloom and J. Van Reenen [25]. Nevertheless, the empirical work of F. Shahzad et al. does not yet convincingly prove that innovation activity is less in the maturity stage than in the growth stage [26]. However, the fact that with the transition to later life cycle stages, innovation shifts from product to process innovation is rather supported by different works of J. Bos et al. and E. Huergo, J. Jaumandreu [27; 28]. The papers hypothesize that the degree of innovation intensity increases during the transition to later stages and depends largely on sector affiliation.

Innovation activity and its impact on market valuation, financial performance, and consequently company cash flows, which determine a company's life cycle stage, according to V. Dickinson [29] can be illustrated by the example of the classical discounted cash flow model (DCF – discounted cash flow) in Figure 1. The peculiarity of innovative companies is the creation of intangible assets (patents, trademark, IT support) within the investment cycle, so many companies classify R&D costs as capital expenditures, in other words, capitalize R&D according to the IFRS standard and the company's accounting policy. Special personal characteristics and experience are required from the company's management given the high risk of the investment, the uncertainty of future cash flows from the patented technology and the long payback period on the invested capital. In particular, whether the efficiency of patent costs (cost efficiency) and high level of patent activity (number of patents) are justified in terms of their significance for the market – cited patent, as well as competitive advantage in the short-term period of 3 years and long-term 3–5 years on revenue, EBITDA and net income [30–34].

Figure 1. Correlation of innovation activity and financial indicators using the example of the DCF model

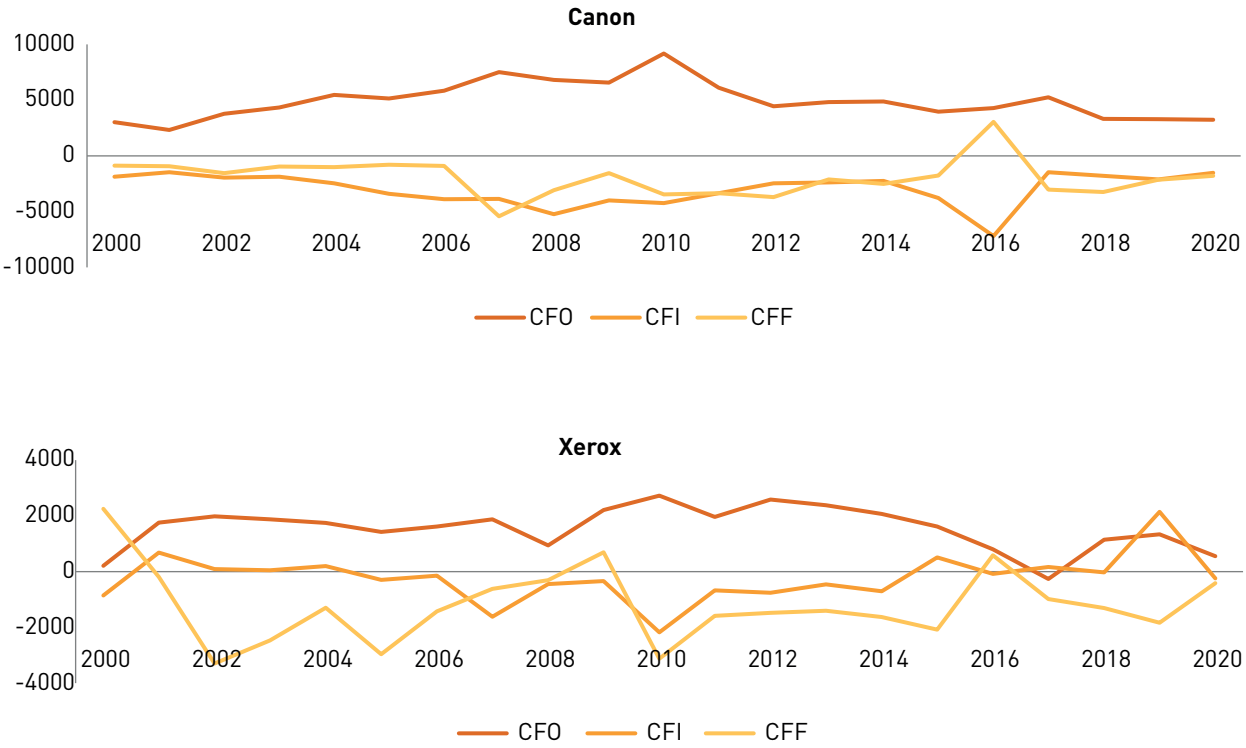


Source: Prepared by authors.

Identification of the life cycle stage of companies in the industry.

The Figure 2 shows the cash flow dynamics of companies such as Canon and Xerox with the definition of the stage of the life cycle according to V. Dickinson [29].

Figure 2. Cash flows of Canon and Xerox (USD, mln)



Source: Prepared by authors.

As can be seen from the Figure 2, all companies are from the same industry and are at the maturity stage, so this sample can be analyzed using certain economic and innovation activity indicators.

Hypotheses

1. *High intensity of innovation relative to competitors in the industry in the long term 3–5 years has a positive impact on the revenue growth rate.*

One of the main metrics of innovation activity in research is innovation intensity, calculated as R&D expenditure to revenue ratio. The indicator allows us to compare Canon and Xerox, which are different in size, in relation to the camera and office printing equipment industries. It is hypothesized that Canon's high innovation intensity allows it to adapt faster to the changing environment and remain a leader by creating value through higher sales of its innovative products. The hypotheses are tested from 2007 to 2020 in an industry transformation, and revenue growth rates are measured from the base year of 2007 [10].

2. *A high level and quality of patent activity above the industry average has a positive impact on the company's financial performance and business margins.*

Significant investment in R&D does not imply a higher level and quality of patenting activity, so one of the issues that the study reveals is how successfully Canon patents its technologies and whether high patent quality (patent citation by other researchers) means higher revenue rates and EBITDA margin relative to competitors [14].

3. *Stable efficiency of innovation spending in the medium term has a positive impact on the EBITDA margin.*

In addition to the quality of patent activity, it is important to analyze the efficiency of innovation spending, in other words, how many patents a company generates on average, all else being equal, per 1 million dollars in R&D investments. This is how we measure the R&D capacity of Canon and its weaker competitor Xerox. The higher this indicator, the more the company maximizes its return on investment [13].

4. *The intensity, quantity, and quality of patents allow companies to remain in the early maturity (prime) stage and not move into late maturity (stability) or the aging stage.*

It is assumed that the results of high innovation intensity – a stable level and quality of patent activity – should increase a company's cash flow in the medium and long term, and as a consequence – the company's market capitalization. Diversification of intellectual capital into other segments, as well as the creation of new products that allow the company to stay longer at the prosperity stage or move to the growth stage can become drivers of growth in difficult conditions [14].

5. *Companies in the growth stage have higher innovation intensity than those in the maturity stage.*

A comparison will be made between Apple's innovation and life cycle performance and that of companies in the printer and camera industry. It is hypothesized that companies in the growth stage should spend more on innovation to ensure revenue and market share growth, while mature companies should be interested in cost reduction, so as to spend less on innovation [18].

Data and Method

For the case study, financial and non-financial data were taken for two main companies: Canon and Xerox. To study industry dynamics, data on the following companies were used: Sharp, Ricoh, Nikon, Apple and HP. Statistical financial data were generated using Bloomberg's information database for 2007–2020, while the other information was gathered from each company's annual reports. Patent information was uploaded from the Orbis Patent Database. Financial and quantitative variables were used to test the hypotheses. The descriptive statistics for each variable are presented in Table 1.

Table 1. Descriptive statistics of variables

Variable	Number of observations	Average	Median	Standard deviation	Coefficient of variation	Minimum	Maximum
R&D to Revenue	95	1.01	0.98	0.16	0.16	0.63	1.53
Revenue growth	97	0.05	0.05	0.01	0.28	0.02	0.09
EBITDA margin	89	0.12	0.11	0.03	0.28	0.03	0.31
Citation per Patent	98	8.88	7.88	0.35	0.04	2.00	19.76
Patent growth	97	1.03	1.01	0.32	0.31	0.41	3.04
Patent to Revenue	98	0.16	0.16	0.03	0.17	0.01	0.57

Source: Calculated by authors.

Descriptive statistics characterize the total sample of balanced data without glaring omissions, the number of observations for which ranges from 89 to 98. Statistics represent relative indicators that are used to prove the hypotheses being tested. It is worth noting that the values of the variation coefficient for such indicators as R&D to Revenue, Citation per Patent and Patent to Revenue are within the normal range from 4 to 20%. However, a relatively greater scatter and lower equalization of the studied values for individual indicators arise due to indicators for individual companies that are distinctive from the industry average. For example, a greater scatter of the revenue dynamics is due to Canon, which has large R&D expenditures compared to the industry average, which were not successful, as clearly seen in the Figure 4. For EBITDA margin, the variation is significant due to Apple's higher margins, which are 30% higher than the industry average, causing right-sided asymmetry. The inflated variation coefficient also indicates the different level of companies' innovation activity, where Xerox causes asymmetry due to the increased number of patents, but their citation and effect on financial results leaves much to be desired. Median and mean values for all indicators are roughly equal, the sample is without obvious omissions. For almost all indicators, the standard deviation is close to zero, which characterizes the lower data **scatter**. All of the above allows us to conclude that the sample is homogeneous.

The first indicator is calculated according to the formula:

$$R\ \&\ D\ to\ Revenue = \frac{R\ \&\ D_{i,t}}{Revenue_{i,t}} \cdot 100\%, \quad (1)$$

where R&D is the amount of money spent by the company on research and development in millions of USD in a particular year, Revenue is the amount of total sales spent by the company in millions of USD in a particular year. This indicator shows how much the company is interested in Innovation Input.

The second indicator shows the level of company's interest in Innovation Output and is calculated according to the formula:

$$\text{Patent to Revenue} = \frac{Patent_{i,t}}{Revenue_{i,t}} \cdot 100\%, \quad (2)$$

where Patent is the number of registered patents held by the company for the current year, Revenue is the amount of total sales spent by the company in millions of USD in a particular year.

The indicator characterizing the degree of income efficiency is calculated according to the formula:

$$\text{Revenue Growth} = \frac{Revenue_{i,t=1}}{Revenue_{i,t=0}} \cdot 100\%. \quad (3)$$

Expenditures on quality new patents developed by companies mostly contribute to the accumulation of competencies to form a platform for further development. Systemic work with innovations requires an adjustment of the operating model, including the improvement of the organizational structure, tools and resources to ensure the necessary speed and flexibility in their implementation. A similar indicator characterizing innovation intensity is calculated using formula:

$$\text{Patent Growth} = \frac{\text{Patent}_{i,t=1}}{\text{Patent}_{i,t=0}} \cdot 100\%. \quad (4)$$

EBITDA margin is defined as the percentage of revenue retained by the company on a pre-tax basis and calculated using formula:

$$\text{EBITDA margin} = \frac{\text{EBITDA}_{i,t}}{\text{Revenue}_{i,t}} g100\%. \quad (5)$$

Patented technologies and a long period of return on invested capital should be justified in terms of their significance for the market and show a high level of patent activity, namely patent citation:

$$\text{Citation per Patent} = \frac{\text{Citation}_{i,t}}{\text{Patent}_{i,t}}, \quad (6)$$

where Patent is the number of registered patents held by the company for the current year and Citation is the number of times the patent has been cited by other researchers.

Table 2 presents the correlation matrix of the variables.

Table 2. Correlation matrix

	R&D to Revenue	Revenue growth	EBITDA margin	Citation per Patent	Patent growth	Patent to Revenue
R&D to Revenue	1.00					
Revenue growth	–0.03	1.00				
EBITDA margin	0.39	0.14	1.00			
Citation per Patent	–0.43	0.20	–0.20	1.00		
Patent growth	0.11	0.05	0.02	0.15	1.00	
Patent to Revenue	0.54	–0.07	0.07	–0.11	0.08	1.00

Source: Calculated by authors.

There is no significant relationship between the variables (the correlation does not exceed 60%), however, the positive relationship between two indicators: Patent to Revenue and R&D to Revenue (0.54) is close to the threshold value. These indicators are compared separately from each other across companies and characterize R&D expenditures as Innovation Output and Innovation Input in order to assess the efficiency of their implementation. Thus, there is no correlation below the threshold value of 60%, which allows us to reject the problem of multicollinearity between the variables.

In 2009, the leaders in the inkjet and laser printer market included Hewlett Packard, Canon, Samsung and Xerox, which accounted for 65–70% of the global market in 2009. The total share held by the leaders in 2000–2010 remained relatively stable, which is explained by the main factors: the image of the supplying company, a good price/quality ratio for each laser or inkjet printer model, as well as a well-thought-out marketing policy, well-developed infrastructure and dealer network. By the end of 2010, the sales performance of printer, desktop MFP, and flatbed and document scanner companies had stagnated. The beginning of the year was not the best in terms of purchasing activity, due to the sharp downturn in 2009 and the slow recovery of demand. In the first half of 2011 there were no significant changes in the market. Showing only token growth, stagnation subsequently turned to decline in 2012 and the market for printing devices contracted in the face of unfavorable economic conditions. Companies needed to upgrade their entire production base in order to expand their product range.

In the high-end copier market, Canon managed to overtake Xerox by continuing its cooperation with HP. Canon increased the production of its own laser printers, controlling about 5% of the market. In the middle of 2012, it became known that due to unfavorable profit forecast, Canon President Uchida would step down and Mitarai would become president again. The news was received positively, but sparked discussions about Canon's dependence on Mitarai. Uchida was given a position as an advisor to the company [35]. Canon continued to operate in its standard segments of camera, optics, and office equipment, and also introduce new technologies and developments. Despite the change in leadership, financial performance in 2011 and 2012 was almost identical. In 2014 alone, the company received more than 4,000 patents in the field of printing, and despite the decline in camera sales Canon managed to increase financial performance with the sale of office devices and printers. Operating income grew by 7.8% to $3 billion and net income by 10.3% to $3.17 billion. By the end of

2015, the company's net income had fallen to $1.8 billion, which prompted another change in management, with Mitarai stepping down as president and Masaya Maeda taking his place. The board of directors decided to downsize from 17 to 6 management members and shift its focus to new industries, taking on new patents in surveillance cameras and commercial printers. The company's sales declined again in 2016, with operating income of $1.9 billion and net income of $1.2 billion.

When considering Xerox, it is worth noting the historical fact that as early as 1985, the inventor of "electrophoto" Chester Carlson assigned the license rights to his patents to the Battelle Institute and Haloid, which used time-limited patent activity to prevent competitors (such as IBM) from making analogs and copiers and securing market dominance. For several decades, Xerox carefully protected its patents from license infringement by competitors. The company owned the most advanced solutions and could have become a market monopolist, but due to the lack of engineers' vision of the final product amid intellectual property restrictions, it could not reach this position [36]. All patented technologies contributed to the infringement of other intellectual property by copying or borrowing original sources. This was the beginning of the deterioration of Xerox's economic potential.

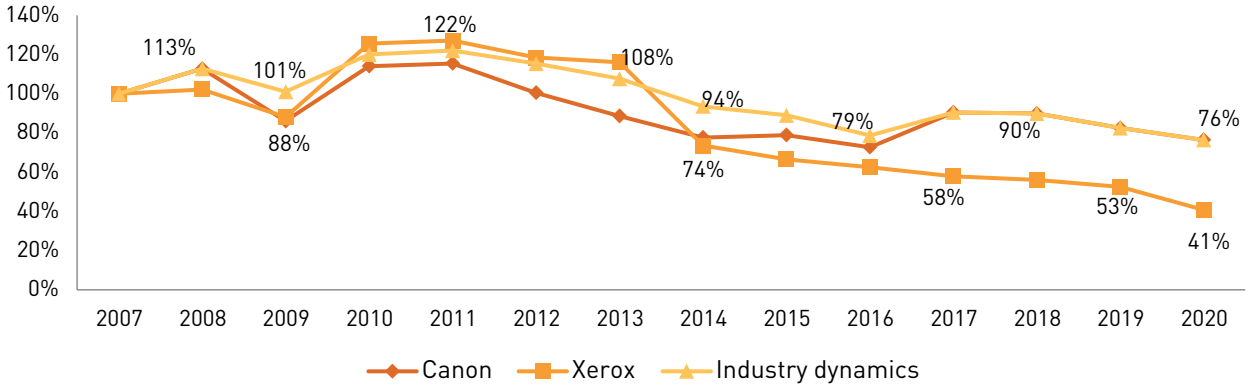
Results

Impact of innovation intensity on revenue dynamics of the companies.

The Figures 3 show that revenue growth in the industry stopped in 2011. Canon's revenue decreased by 23% over 13 years, while Xerox lost 60% of its revenue over 13 years.

Of all the companies, Canon had the highest innovation intensity. The worse the revenue dynamics were, the more Canon invested in innovation. Xerox, on the other hand, reduced its innovation intensity as its revenue decreased, which resulted in the company preserving only 40% of its 2007 revenue in 2020. Comparing Canon with its competitors, we cannot say that its high level of innovation intensity had a positive impact on revenue, but Xerox's low innovation intensity may have had an impact on revenue decline. Since no definite conclusions can be drawn, Hypothesis 1 is rejected.

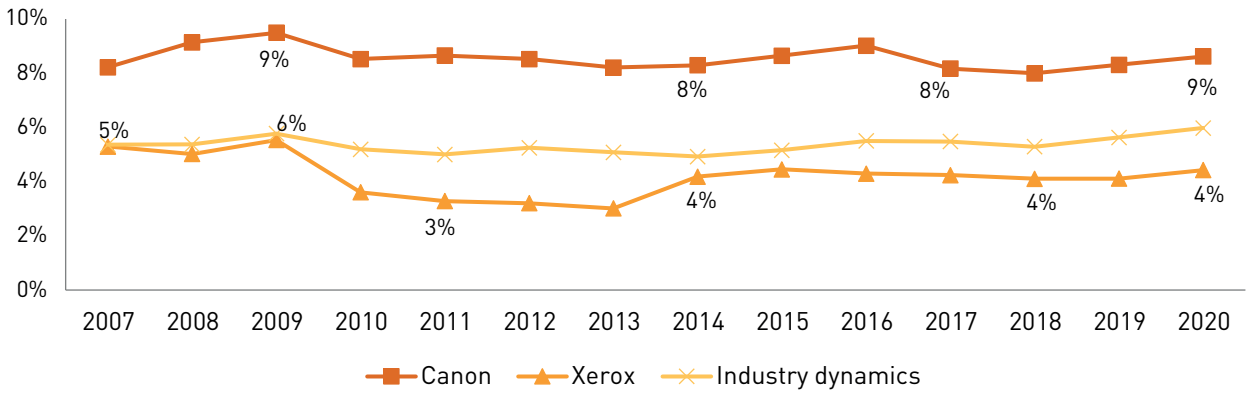
Figure 3. Revenue growth dynamics in 2007–2020



Source: Prepared by authors.

Analyzing the revenue dynamics, it is worth noting that the sharp growth of Xerox's revenue from 2009 to 2012 was caused by a new direction taken up by the company – electronic document management services. In 2009 their share amounted to 3.5 billion dollars, in 2010 it grew to 10 billion, but by 2014 it fell to 4 billion. Most likely, Xerox lost this segment to other, more technologically advanced companies. This indicator is calculated according to formula (3).

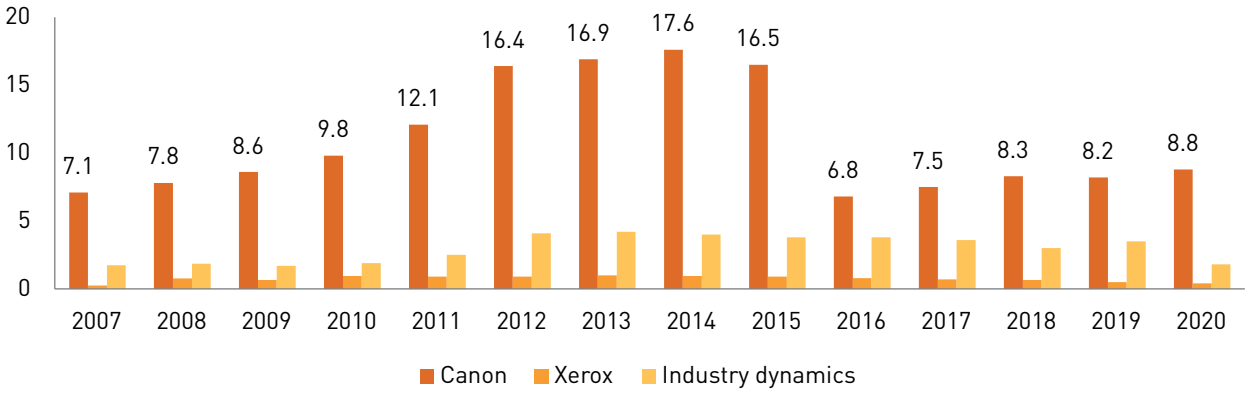
Figure 4. R&D to revenue ratio from 2007 to 2020



Source: Prepared by authors.

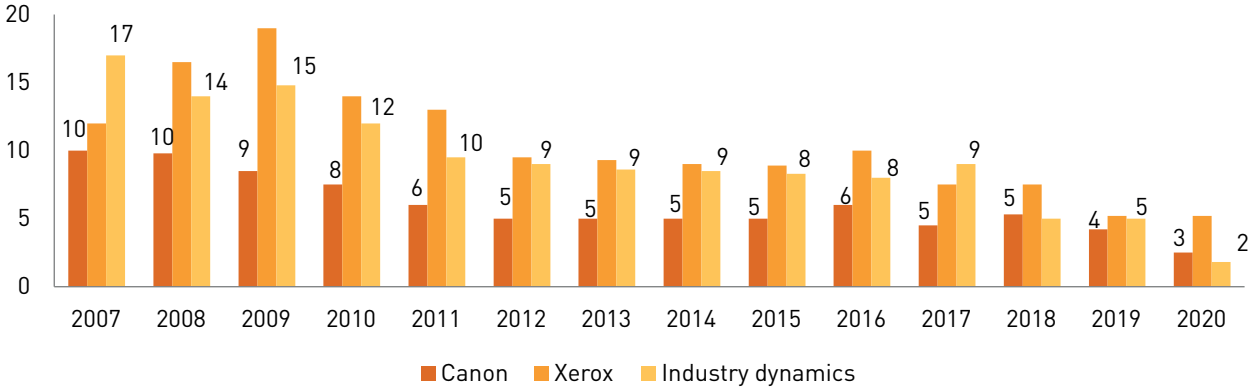
High R&D spending has helped Canon to create new business units, without which, the company would have lost half of its revenue over 13 years. This is characterized by Figures 4. As a result, it is difficult to determine how Canon's high innovation intensity has affected revenue compared to other companies, but it is worth noting that without it, Canon could have ended up in Xerox's shoes. This indicator is calculated according to formula (1).

Figure 5. Patent growth dynamics in 2007–2020



Source: Prepared by authors.

Figure 6. Average citation per patent in 2007–2020 (1000 per patent)



Source: Prepared by authors.

Impact of patent activity on the company's financial results

An analysis of the results of innovation intensity of Xerox and Canon allowed to show that the latter's indicator is significantly above the level in the industry and comparable companies, but the revenue is growing at a comparable rate with its peers. Therefore, it becomes an important task to compare the patent activity metrics – numbers and citations. Figure 5 shows that Canon is well ahead of Xerox and the industry average in terms of the number of patents. This has allowed the company to remain one of the market leaders in the camera[1] и printer[2] sectors. This is partly a consequence of high innovation intensity. The number of patents grew steadily until 2015, while the pace slowed down in subsequent periods. Since 2016 the number of patents has halved, which is probably due to the fact that new discoveries in the optical devices and office printing equipment industry were not yielding results, and in 2015–2017 the company invested part of its R&D potential in the new segments – semiconductors and medical devices. On the contrary, Xerox exhibited low patent activity below the industry average, even with regard to the difference in company size (on average, Canon's revenue was 2.7 times higher than Xerox's, and the number of patents was 13 times higher during the period in question). As a result, the company lost 58% of its revenue by 2020, losing the competition and failing to follow a strategy of entering new markets.

The indicator illustrating the quality of patents is the citation of existing inventions by other researchers. Meanwhile, given the different levels of patent activity, a relative indicator – the average citation rate per patent – was calculated. Figure 6 shows that Canon's citation rate is significantly lower than Xerox's and the overall industry dynam-

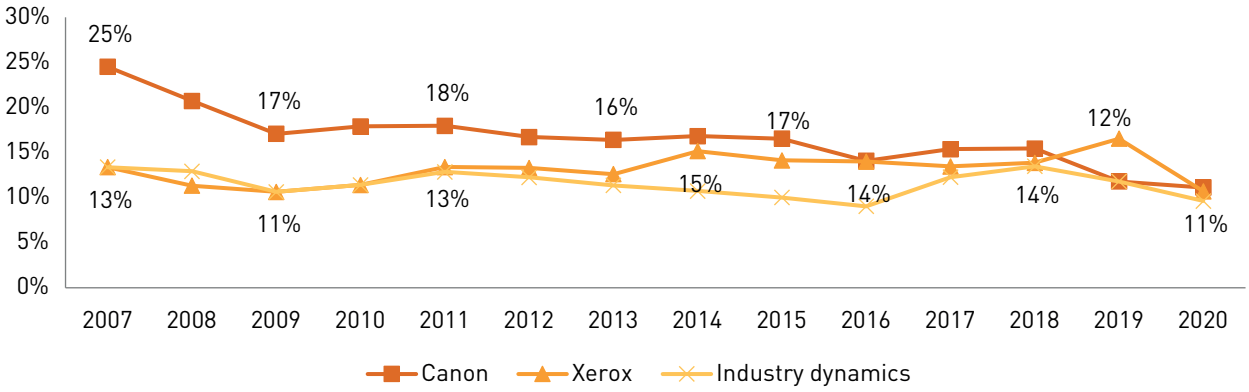
[1] URL: https://www.digitalcameraworld.com/news/camera-market-share-canon-owns-48-sony-22-nikon-drops-to-14

[2] URL: https://www.statista.com/statistics/541347/worldwide-printer-market-vendor-shares/

ics, which to some extent may explain the weak revenue growth despite high patent activity. This indicator is calculated according to formula (4).

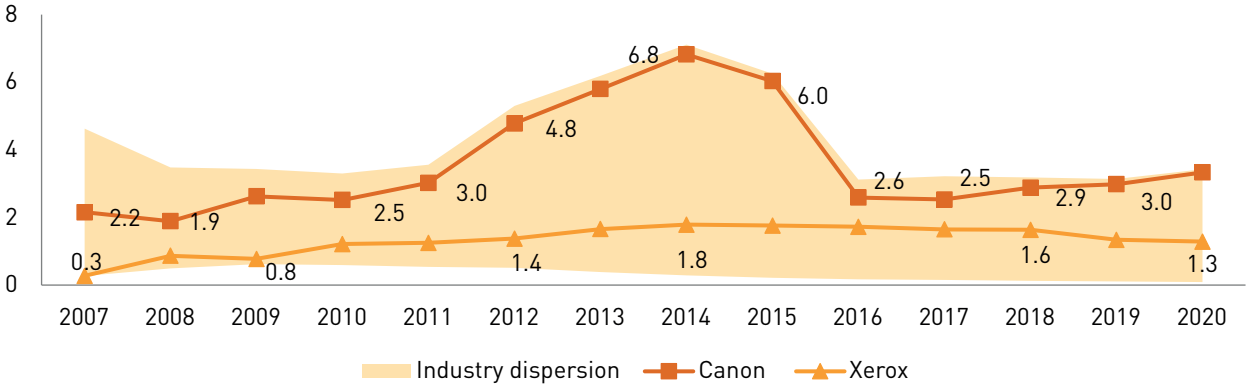
Innovative development requires a potentially different amount of investment to build a strong and sustainable competitive advantage in the market. It should be noted that the main effect of innovation is achieved through productivity growth, which further promotes the introduction of advanced technologies and approaches to the organization of internal processes, which in turn generate profits from sales of new products. However, the period from the initial research to commercialization can take 10 to 20 years, therefore, all scientific innovations require long-term efforts, which are stimulated by long-term investments in R&D [37]. This indicator is calculated according to formula (6).

Figure 7. EBITDA margin in 2007–2020



Source: Prepared by authors.

Figure 8. Impact of patent cost efficiency on revenue of Xerox and Canon (Patents/USD mln)



Source: Prepared by authors.

As seen in Figure 7 above, high patent activity leads to lower EBITDA margin in the mid-term assessment period. In the case of Canon and Xerox, Canon viewed R&D and patents as a way to increase sales and revenue solely from a long-term development perspective, leading to a EBITDA decrease from 25 to 11%. Xerox viewed R&D as an expense to create new value chains, and as a result shifted short-term profitability zones, whereby the company was able to grow the net margin by 3.5% over 3 years, but deprived itself of revenue. Unlike operating businesses, innovation activities have a fundamentally different risk profile and less predictable performance. Therefore, it is necessary to use special methods such as portfolio management and adaptation of corporate culture, as well as a certain motivation system within companies. As a result, we can conclude that **Hypothesis 2** is rejected. This indicator is calculated according to formula (5).

Canon vs Xerox innovation cost efficiency

Analysis of the efficiency of innovation spending as a ratio of the total number of patents to R&D expenditures in Figure 8 showed that Canon's ratio was more volatile than Xerox's, although to some extent it followed the spread of minimum and maximum values in the sector. Given the stable R&D expenses to revenue ratio in the range of 8–9% over the past decades, their efficiency has been declining markedly since 2014–2016 amid the restructuring of the company's business model through M&A deals and the development of new promising business lines – commercial printing, IP cameras, medical and industrial equipment. At the same time, Xerox followed a conservative strategy and tried to strengthen its potential in a stagnant market without seeking to improve the efficiency of R&D spending. As a result, Canon is largely maximizing its re-

turn on investment compared to Xerox, but not exceeding the industry average. However, the EBITDA margin dynamics does not allow us to draw unambiguous conclusions regarding this indicator, and therefore **Hypothesis 3** is rejected. This indicator is calculated according to formula (2).

Impact of innovation intensity on the life cycle.

As shown in Table 3 below, over 20 years, Canon was in a predominantly flourishing stage (CFO>0; CFI <0; CFF <0), while Xerox had periods of stability (CFO>0; CFI>0; CFF <0) and aging. This suggests that Canon's high innovation intensity allowed the company to remain at an earlier stage than Xerox.

Table 3. Change in the life cycle stages of Canon and Xerox in 2000–2021

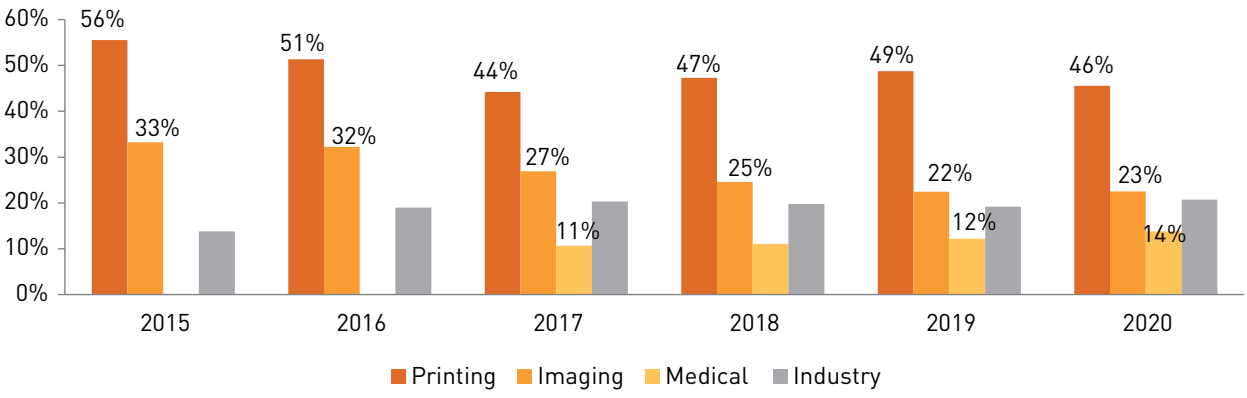
Canon						Xerox					
Year	Stage	Year	Stage	Year	Stage	Year	Stage	Year	Stage	Year	Stage
2000	Prime	2007	Prime	2014	Prime	2000	Growth	2007	Prime	2014	Prime
2001	Prime	2008	Prime	2015	Prime	2001	Stable	2008	Prime	2015	Stable
2002	Prime	2009	Prime	2016	Growth	2002	Stable	2009	Growth	2016	Growth
2003	Prime	2010	Prime	2017	Prime	2003	Stable	2010	Prime	2017	Decline
2004	Prime	2011	Prime	2018	Prime	2004	Stable	2011	Prime	2018	Prime
2005	Prime	2012	Prime	2019	Prime	2005	Prime	2012	Prime	2019	Stable
2006	Prime	2013	Prime	2020	Prime	2006	Prime	2013	Prime	2020	Prime

Source: Calculated by authors.

It is worth noting that in 2016 both companies were at the growth stage. This was facilitated by the increased innovation intensity in the previous 3 years. Xerox moved into the aging stage in the following year, and even its spending on innovation could not help the company's growth and product creation. Meanwhile, Canon entered new markets with increased innovation intensity, thereby diversifying its revenue. It entered the semiconductor manufacturing market in 2015 and the medical device market in 2017. The share of revenue from semiconductor manufacturing has increased from 13% in 2015 to 20% in 2020, and the share from medical devices – from 10% in 2017 to 13% in 2020. Canon thus has a better chance of staying in its prime than Xerox, which has never been able to enter new markets.

Hypothesis 4 is not rejected.

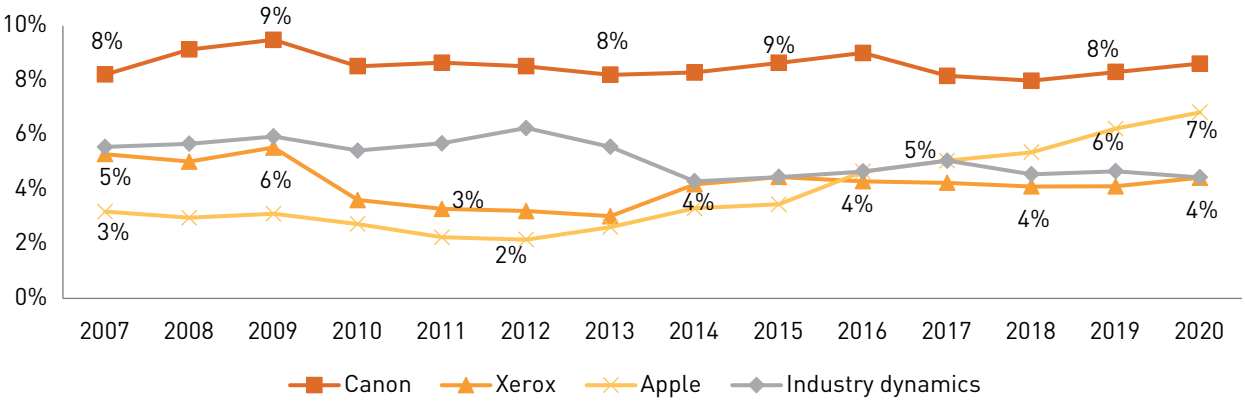
Figure 9. Canon's revenue structure in 2000–2020 (USD)



Source: Prepared by authors.

As shown in Figure 9, the printing and imaging industries accounted for the bulk of revenue, with a share consistently exceeding 40% for 5 years for printing.

Figure 10. Comparative characteristic of innovation activity of companies in the industry of IT at different life cycle stages



Source: Prepared by authors.

Table 4. Changes in the stages of Apple's Life Cycle in 2000–2020

Year	Stage	Year	Stage	Year	Stage
2000	Prime	2007	Growth	2014	Prime
2001	Prime	2008	Growth	2015	Prime
2002	Growth	2009	Growth	2016	Prime
2003	Prime	2010	Growth	2017	Prime
2004	Prime	2011	Growth	2018	Stable
2005	Growth	2012	Prime	2019	Stable
2006	Prime	2013	Prime	2020	Prime

Source: Calculated by authors.

This indicator is calculated according to formula (4). As can be seen in Figure 10 above, Apple's innovation intensity has long been lower than Canon's and the printer market as a whole. This is especially evident when Apple was in the growth or blossoming stage, the stages of the life cycle of which are summarized in Table 4.

However, from 2013 onwards, the company began to increase innovation intensity, and by 2020, it has maximized the gap with Canon. One explanation for this phenomenon is that after the 2007–2011 period, the company entered the maturity stage, and in 2018-2019 it entered the aging stage. The increase in innovation intensity may indicate that Apple is trying to move out of the maturity and aging stage into the growth stage.

Hypothesis 5 is rejected. Innovation intensity increases when companies in later stages reenter the growth stage.

Conclusion

The analysis of the impact of innovation activity on the financial performance of Canon and Xerox in comparison with competitors showed that exceeding the industry average in terms of the number of patents and innovation intensity does not always lead to higher financial results in the short and medium term. Nevertheless, a small effect on the company's revenues and cash flows was observed in the long-term horizon, which confirms the conclusions in research conducted by Anabela S. In particular, the company's high intensity of innovation and Canon's innovation expansion strategy help diversify its revenue into other knowledge-intensive industries, keeping the company at an earlier maturity stage. Nevertheless, it has not been able to significantly outperform its competitors, probably due to weak patent quality and average innovation spending efficiency. This observation refutes the conclusions from the research evidenced by S. Kwon and A. Marco [14]. Meanwhile, Xerox will probably be unable to maintain its stable position in the market, gravitating towards the life cycle stage of decline. The company's current strategy of optimizing costs through innovation in business processes allows it to preserve its EBITDA margin at a high level, but the slowing revenue and low innovation intensity is rather distancing it from its competitors. Apple was also studied for comparison. According to the results of the analysis, it appeared that this company demonstrated a low innovation intensity during the growth stage, but when it started to transition to the stage of prosperity and stability, it significantly increased its innovation intensity. This can be explained by the fact that Apple realizes that without new innovations the company will lose its leading industry position and miss new opportunities, which will lead it to the aging and stability stage. The results of the study

can be used by financial analysts and academics to analyze the probability of making the right choice of the company's development strategy under conditions of uncertainty and declining economic potential. It's worth noting that industry growth is slowing down as investment in research and development becomes less efficient, external controls increase, and companies become increasingly forced to collaborate with each other on innovation, creating more complex management and control structures. This trend negates the need for new products, however, companies should focus on the diversification of their products, as well as the variety of services provided, not limiting themselves to just one specification. A company should have a clear financial plan, control its expenses, and invest in marketing campaigns and promotion of products and services in the market, which will help increase brand awareness and attract new customers. Moreover, it will promote innovation in stagnant industries and increase the likelihood of moving to a higher and more stable stage of growth.

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