ORIGINAL PAPER

Tomasz L. Nawrocki
Silesian University of Technology, Poland

Opportunities and threats associated with an investment in shares of innovative companies — evidence from Polish capital market

Abstract

Research background: Since the Internet bubble, which took place at the turn of XX and XXI century, on the global capital markets, including Poland, one may note a growing interest in companies focusing on innovations and innovativeness. The main driver of this interest is the belief that in a longer term innovations and expenditures on research and development will translate into an increase in competitive advantage, financial results, and subsequently also the market value of companies. On the other hand, the attention should also be paid to the fact that innovative activity has also another, darker, side, which is identified with the far-reaching uncertainty about its final effects and the possibility of incurring losses, especially in financial dimension. At the same time, it should be noted that implementation of investment strategy regarding the shares of innovative companies is quite troublesome because of the lack of unified methodology for assessing corporate innovativeness and large information diversity in this area.

Purpose of the article: The investment efficiency analysis of investment strategy regarding shares of companies perceived to be innovative with simultaneous focusing on the different cases of situation development in time.

Methods: The research was carried out for companies listed on the main market of the Warsaw Stock Exchange, taking into consideration various time ranges of investment. The efficiency analysis of this investment strategy was conducted in the risk-return outlay with

the use of such measures as: accumulated rate of return, arithmetic average rate of return, standard and semi-standard deviation, as well as coefficients of variation and semi-variation of rate of return and their inverses.

Findings & Value added: The obtained results show that in shorter periods of time, investors buy expectations connected with innovative companies and therefore, the efficiency of investment in their shares is relatively high, but in the longer term expectations are revised by companies' financial results, which in turn often negatively affects the investment efficiency.

Introduction

Among many investment strategies that can be applied on the capital market (Jajuga, 2009; Damodaran, 2012) more and more attention in recent years has been paid to investing in shares of innovative companies. Undoubtedly, the growth of popularity of this group of companies among stock market analysts and investors was driven by the dynamic, supported by rising shares quotations, development of a number of entities known in the world from systematically introduced innovations, including breakthrough ones, e.g. Alphabet (earlier Google), Apple, Amazon, Netflix (in line with the improvement of financial results, shares prices of these entities in the period from the bottom of the previous bear market, dated at the turn of 2008 and 2009, increased by March 2017 by 607%, 1271%, 2442%, and 5554%, respectively, while NASDAQ Composite index increased by 371% in the same period). Not without significance was also the period of the 90's of the 20th century and a large increase in the market value of technology companies on the wave of spreading the Internet and development of information technology (in the US, the technology companies index — NASDAQ Composite increased by 1094% from August 1990 to November 1999), while indexes relating to more traditional companies — S&P500 and DJIA30 — gained 380% and 340%, respectively, at the same time).

On the Polish capital market, so far, it is in vain to look for entities similar in terms of the scale of innovativeness to the aforementioned ones, although the group of companies that can be considered as innovative systematically grows. The expansion of their list is supported by the activity of venture capital and private equity funds, as well as the launch by the WSE in 2007 the New Connect market, dedicated to start-up entities. As a result, we can observe an increasing interest of investment environment in shares of innovative companies, including launching dedicated investment funds (e.g. PKO Innovative Companies Global FIO, PKO Technology and Innovations Global FIO, Trigon Venture FIZ). A general attractiveness of investments in shares of innovative companies listed on the Warsaw Stock

Exchange is also confirmed by research results (Prorokowski, 2014, pp. 32–52; Nawrocki, 2016a, pp. 53–60)

At the same time, it should be noted that implementation of the investment strategy focused on innovative companies is a kind of challenge, especially for individual investors, whose access to the information is not necessarily full, and the possibilities of their processing are often limited. One of the main problems in this area is the identification of innovative entities, which results, among others, from highly diversified information policy of individual companies, as well as ambiguities of terms such as innovation, innovativeness and innovative (Fagerberg *et al*., 2012, pp. 1132–1153; Nawrocki, 2012).

In addition, it is also necessary to pay attention to the issue of high risk of enterprises' innovative activity, which is connected with the unpredictability of its final results and the need to incur significant expenditures, often in a longer period of time (Tellis & Golder, 1996, pp. 65–75; Świtalski, 2005). As a result, uncertainty about the recoverable rate of return on investments in shares of this type of entities is significant, which means that it is not a strategy for everyone, and certainly not for investors who value security and limited volatility of the investment portfolio.

Although in the financial media the subject of investment in innovative companies is being discussed from time to time, in the field of science, compared to investment strategies in the stocks of growing, value or dividend companies, it enjoys fairly limited popularity. Research presented in the literature focuses more often on the relationship between innovative effort undertaken by enterprises and their performance (e.g.: Hult *et al*., 2004, pp. 429–438; Artz *et al*., 2010, pp. 725–740), or value (e.g.: Hall, 1999; Lev, 2001). For this reason, in order to bring the effectiveness of such an investment approach closer and accompanying opportunities and threats, the main objective of this article is to investigate the changes in risk and returns related to the implementation of the investment strategy regarding shares of innovative companies. As a reference point, the broad Polish stock market index — WIG was assumed. As the measures of risk and return the following were used: the accumulated rate of return, the arithmetic average rate of return, the standard and semi-standard deviation, as well as the coefficients of variation and semi-variation of rate of return and their inverses.

At the same time, the following research hypothesis was verified: in a shorter period, investors buy expectations related to innovative enterprises, hence the return on investment in their shares is relatively high, but in a longer time horizon these expectations are verified, which in turn often results in a drop of these entities market value.

Apart from the introduction, the article consists of five parts concerning, in turn: literature review, basic assumptions and research methodology, obtained results, discussion the results in the context of other research, including in particular international ones, and conclusions.

Literature review

In the literature, innovation and innovativeness are perceived as engines driving economic development, which was first noticed by Joseph A. Schumpeter in his vision of creative destruction, referring to the mechanism of changes in the capitalist economy (Schumpeter, 1960). Although the theory of innovation proposed by Schumpeter refers to the economy from the first half of the 20th century, the importance of innovation has not devaluated over time, but on the contrary it has become one of the main determinants of competitiveness (e.g.: Prahalad & Hamel, 1990, pp. 78–90; Lichtarski, 1999). The pressure on innovation and innovativeness in recent years is particularly strong and visible in various contexts, including the capital market where separate segments dedicated especially to innovative companies were created — NASDAQ stock exchange in the US, and New Connect segment, and earlier the TECHWIG index, in Poland on the Warsaw Stock Exchange.

From a scientific perspective, as noted earlier, the main focus of research and publications on innovativeness is focused on the relationship between innovative activity of enterprises and their financial results. On the other hand, in the context of capital market, fewer studies in this area focus on, generally positive, relation between innovativeness and the level of shares quotes, taking into account at the same time the cyclical nature of the economy (e.g.: Jovanovic & MacDonald, 1994, pp. 322–347) and the links between the market value of enterprises with their patent activity (e.g.: Pakes, 1985, pp. 390–409; Hall *et al*., 2005, pp. 16–38), or the efficiency of innovative activity (e.g.: Hirshleifer *et al*., 2013, pp. 632–654). On the other hand, there are relatively few publications focusing on uncertainty related to the innovative activity of enterprises and its translation into the risk and volatility of their share prices. Certain research in this regard in relation to enterprises from various sectors of the economy has been made among others by Mazzucato (2006, pp. 159–179), but the conclusions from it focus on the general population within these sectors and do not take into account the analysis of the various cases within them.

It is also worth noting that, according to some authors (e.g.: Ballardini, 2005), research on enterprise innovativeness should generally be considered problematic, which results from the ambiguity of this concept and various criteria for its evaluation/measurement used by individual researchers. This causes individual conclusions to be often of a non-universal nature, but rather referring to a particular approach used in the study.

The phrase "innovative company" is intuitively associated with a company that conducts activities focused on the development and implementation of innovation — the so-called innovative activity (OECD/European Communities, 2005) — or is characterized by a certain above-average level of innovativeness. At the same time, however, due to the ambiguity of the concepts of "innovation" or " innovativeness", also with reference to the term "innovative company" it is difficult to indicate its specific definition.

Since Schumpeter's introduction of the innovation concept to economic theory (Schumpeter, 1960), its importance has evolved to adapt to the changes that have occurred in the global market economy. The term innovation is on the one hand related only to significantly changed or new solutions (OECD / European Communities, 2005), and on the other, identified with all changes recognized by people as novelty in relation to the previous state (Kotler, 1994). Innovations are also considered in terms of the subject — as a result (there is an additional distinction between product, process, marketing and organizational innovations), or in functional terms — as a process (Goldsmith & Foxall, 2003, pp. 321–330).

Like innovations themselves, also innovativeness is presented in the literature in various contexts and also in this case it is difficult to define one commonly binding definition. Most often understood by this concept is the specific ability of an organization to constantly seek, implement and disseminate innovations (Pomykalski, 2001). It should be noted that many definitions of innovativeness go beyond displaying only the ability or skills itself, also emphasizing the results of its possession and use. In this approach, organization's innovativeness is perceived as a mastery and maintenance of high dynamics of value creation, which manifests itself in using opportunities for change and generating, processing and implementing new ideas into practice (Jin *et al*., 2004, pp. 255–64), earlier than other organizations do (Rogers, 1995). It is also worth noting that innovativeness should not be an objective itself, but allow an enterprise to effectively allocate resources, leading to the creation of an optimal configuration of competitive advantages (Morgan & Berthon, 2008, pp. 1329–1353). In this understanding of innovativeness, the most important is connection of ability to implement innovations with final results of this implementation (Prajogo, 2006, pp. 218–25).

In connection with the above, it cannot be surprising that the perception of the term "innovative enterprise" often varies. In the most narrow understanding, such organizations are characterized by conducting research and development activity (regardless of whether with or without success), or by implementing at least one innovation in the period under consideration, usually 3 years (OECD/European Communities, 2005). In turn, in a broader sense, an innovative organization is one that not only conducts research and development and implements innovative solutions, but can also anticipate and adequately react to changes in the environment, and stands out in terms of possessed resources, including non-material ones and the efficiency of their allocation, as well as the level of modernity and competitiveness (Sosnowska *et al.*, 2000; Onag *et al.*, 2014, pp. 708–717).

Summarizing the above considerations, it can be concluded that instead of an acute delineation of non-innovative and innovative entities, it would be better to talk about non-innovative entities and more or less innovative ones, which should be accompanied by appropriate reference framework. If, in addition, the issues of sectoral affiliation of enterprises and their information policy in the field of innovative activity are taken into account, it can be stated that in case of identification of innovative enterprises, it is difficult to avoid some subjectivisms.

Research methodology

For the purposes of realization the main objective of the paper, the following course of action was adopted:

1. *Identification of the research entity — innovative companies listed on the Warsaw Stock Exchange.* Taking into account previous research on the involvement of Polish companies in innovative activities (Nawrocki & Żabka, 2011, pp. 3–12), it was decided to limit the considerations to companies in which research and development activities, or more broadly innovative, are located more within the main business process than auxiliary processes, as is e.g. in the case of banking, chemical or clothing sector. In connection with the above, the subject of the study was limited mainly to the so-called new economics companies, i.e. representatives of the IT sector (information technology and information and communication technology — IT and ICT) complementing the list with companies from the pharmaceutical sector, marketing media, computer game developers, and postal services.

2. *Determination of the analysis time scope.* Considering the issues of maximizing the sample size, the cyclicality of the stock exchange situa-

tion and the appropriately long time series counted in years, the scope of the analysis was decided to include the period from the beginning of 2009 (beginning of the current long-term upward trend) until the end of 2016.

3. *Analysis of the return on investment in shares of innovative companies and the WIG broad market index over time*. This analysis is assumed to be carried out on the basis of a growing in time compounded rate of return taking into account subsequent monthly periods of analysis (1):

$$r_c = \prod_{t=1}^{n} (1 + r_t) - 1,$$

(1)

where:
n – number of periods from which data was taken,
r_t – rate of return in the t-period.

4. *Efficiency analysis of investment in shares of innovative companies and the WIG broad market index*. This analysis was assumed to be performed in the risk-return layout based on monthly rates of return and using: the expected rate of return on the basis of arithmetic mean (2), standard deviation (3), semi-standard deviation (4), coefficient of variation (5) and coefficient of semi-variation (6) of the rate of return:

$$\bar{r} = \frac{1}{n} \sum_{t=1}^{n} r_t,$$

(2)

$$s = \sqrt{\frac{\sum_{t=1}^{n} (r_t - \bar{r})^2}{n - 1}},$$

(3)

$$ss = \sqrt{\frac{\sum_{t=1}^{n} d_t^2}{n - 1}}, \text{where: } d_t = \begin{cases} r_t - \bar{r}, & \text{when } r_t - \bar{r} < 0 \\ 0, & \text{when } r_t - \bar{r} \geq 0 \end{cases}$$

(4)

$$CV = \frac{s}{\bar{r}},$$

(5)

$$sCV = \frac{ss}{\bar{r}}.$$

(6)

It should be noted that while in terms of the rate of return their higher values (higher investment income) are more desirable, in case of standard deviation and semi-standard deviation lower values are considered more favorable, meaning lower risk in absolute terms. Due to the fact that, contrary to the average rate of return, standard deviation and semi-standard deviation always take values above zero, in order to avoid interpretation doubts at a negative rate of return, with respect to coefficients of variation and coefficient of semi-variation, it was decided to base on the inverse of their values (1 divided by value of *CV* and *sCV*). In this form, they inform how much income there is per unit of risk, and therefore, similar to the rate of return, higher values are more preferred.

Results

Following previously described code of conduct, firstly the selection of companies listed on the Warsaw Stock Exchange in the analysis period (2009–2016) was conducted, taking into account their innovativeness and affiliation to the industry sectors indicated earlier. After the selection, a list of 25 entities was obtained, the enumeration of which is included in Table 1, together with information on the dominating trend of their shares (using the linear regression line and the R^2 adjustment factor), the final rate of return in the period 2009–2016, as well as its minimum and maximum level.

The results of the conducted study were presented in two perspectives — a general one, covering all considered innovative companies together, and a more detailed one, where the investigated companies were divided into five subgroups, taking as the division key the tendency of their shares quotations: companies in a strong rising or downward trend ($R^2 > 0.5$), companies in a weak rising or downward trend ($0.5 \geq R^2 > 0.2$), companies in a sideway trend, or showing a variable tendency of shares quotations — increase-decrease, or decrease-increase ($R^2 \leq 0.2$).

Going to the presentation of obtained results, the focus was primarily on the overall approach and calculated on the basis of monthly quotations growing compound rates of return on shares of innovative companies and the WIG index in subsequent, extended each time for a year, time periods (Figure 1). For more complete picture of the situation, in addition to the result at the end of the given period, the recorded maximum and minimum values were also taken into account (the initial value was always zero). In case of innovative companies, the presented values have the character of

the average of individual features (closure, maximum, minimum) for the whole research sample.

The obtained results indicate the continuously growing advantage of innovative companies over the WIG broad market index in terms of the achievable rate of return, with simultaneously much greater volatility of quotations — upper and lower wicks in case of individual candles symbolize the maximum and minimum rates of return in a given period.

The picture of the situation outlined above was then subjected to an additional analysis of investment efficiency in the risk-return outlay (Figures 2–4), also carried out for individual time ranges based on monthly rates of return (for innovative companies presented values are the averages of individual values for the entire sample).

Taking into account the obtained results, it can be stated that while in a longer time horizon investors investing in shares of innovative companies can count on a higher rate of return compared to the broad market (Figure 2), at the same time such strategy is burdened with much higher risk (Figure 3), in particular so-called negative risk (rate of return less than the average for a given period), whose measure in the analysis is the semi-standard deviation. Consequently, this also translates into significantly less favorable values of inverses of the variation and semi-variation coefficients (Figure 4). It should also be noted that, in contrast to the broad market index, in the case of innovative companies' shares, the risk measured by standard deviation and semi-standard deviation, along with the extension of the investment period is not systematically reduced, but rather quickly stabilizes at a relatively high level. Thus, it can be stated that the research hypothesis set at the beginning is confirmed, which better reflects the second, more detailed, recognition of the results, taking into account the division of the investigated companies into subgroups due to the tendency of quotations (Figures 5–8).

Even in the case of companies with a strong upward trend in the third and fourth year of analysis, there is a clear correction of the previous positive trend, which is reflected in longer upper wicks of candles symbolizing the growing compounded rate of return (Figure 5), clearly lower average monthly rates of return (Figure 6), stabilization or even an increase in standard deviation and semi-standard deviation (Figure 7) and relatively less favorable inverses of variation and semi-variation coefficients (Figure 8). Negative changes in the investment efficiency lasting longer than one or two years are particularly visible in relation to companies characterized by a sideway or changing and downward trend, where along with the extension of the analysis, individual income and risk measures, as well as their

mutual relations generally deteriorate, or at best, they remain at an unattractive level.

In order to better describe the specificity of particular groups of innovative companies, below (Figures 9–11) their most prominent representatives are presented within the considered research sample, taking into account the growing compound rate of return and financial results.

With regard to the companies with a strong upward trend of share prices (Figure 9), on the one hand, we have CD Projekt, where high market expectations were met by successful successive versions of the game from „The Witcher" series, which was also reflected in the reported financial results, and, on the other hand, Asseco Business Solutions, whose stock is steadily climbing upwards with higher and higher financial results.

The representatives of the subgroup of innovative companies characterized by a changing trend of their share quotes, presented in the Figure 10, are the most adequate example to the research hypothesis presented in the paper. Both companies — Integer.pl and PZ Cormay — initially "conquered" the market with innovative solutions (respectively — parcel lockers and blood analyzers), however, in a longer term they were not able to meet investors' expectations. Not fast enough development of the market (Integer.pl) and long-lasting work on new solutions (PZ Cormay) translated into financial results which were disappointing for investors and led to a significant value decrease of their shares on the WSE.

The biggest losers in the analyzed period were two companies characterized by a strong downward trend — B3 System and Bioton (Figure 11). In both cases, after a one-year stock quotes growth, their radical sell-off came as a result of investors' disappointment with both the pace and prospects for the development of companies and reported financial results. In addition, the investors' perception of both companies was influenced by issuing new shares, which were used to rescue them from deteriorating financial situation, and which did not change much in terms of core business performance.

Discussion

As it was previously noted, the literature concerning research on the efficiency of investment in shares of innovative companies, which would take into account both the issue of rates of return and investment risk (volatility of rates of return) is quite poor. Regarding the rates of return on shares of innovative companies, there is a general agreement about the positive relation with their innovativeness (e.g.: Nawrocki, 2016a, pp. 53–60; Proro-

kowski, 2014, pp. 32–52; Hall *et al*., 2005, pp 16–38), but as shown by the results obtained in the course of the study, it is only one side of this issue. Taking into account the risk expressed by standard deviation or semi-standard deviation, investment in innovative companies is losing a lot of its attractiveness. However, it should be noted that there is a significant diversity of situations within this group (some of innovative companies presents more favorable than the broad market in terms of investment efficiency, some are more or less at the same level and others are much lower in minus), which partly confirms the conclusions received by Mazzucato (2006, pp. 159–179), who indicates, within individual sectors of the economy, a significant differentiation of ″ innovativeness — volatility of returns on shares" relation.

Conclusions

The analysis of the efficiency of investment in shares of innovative companies carried out in the paper indicates that the strategy of this type, on the one hand, gives clearly higher rates of return compared to a broad market given by the WIG index, but on the other, it is accompanied by a relatively higher risk, which also often translates into less-favorable readings of inverses of variation and semi-variation of rates of return coefficients.

It should be also noted that the conducted research, due to the use of a simplified approach, was mainly limited to the so-called new economics enterprises, without applying more sophisticated criteria for the selection of innovative companies. This regards also to entities from more traditional sectors of the economy. In the course of practical implementation of the investment strategy in shares of innovative companies, it would be necessary to consider full opening to the sectoral affiliation of potential objects of interest and the application of certain selection criteria that will be relatively easily applicable.

Appropriate identification of innovative entities and quick capture of potential threats related to their operations and development prospects is undoubtedly of great importance for the results of such a strategy. However, it should be noted in this context that often the issuers of securities listed on the capital market do not make this task much easier by conducting a very diversified, including most often selective and chaotic, information policy regarding innovative activity and its results. On the other hand, however, it creates opportunities for further, more in-depth research in this area. In particular, they may relate to the relationship between companies' information policy in the field of innovative activity and their perception

(valuation) by the market (investors), or the methods of identifying innovative companies based on publicly available information.

References

Artz K. W., Norman, P. M., Hatfield, D. E., & Cardinal, L. B. (2010). A longitudinal study of the impact of R&D, patents, and product innovation on firm performance. *Journal of Product Innovation Management*, *27*(5). doi: 10.1111/j.1540-5885.2010.00747.x.

Ballardini, F., Malipiero, A., Oriani, R., Sobrero, M., & Zammit, A. (2005). Do stock markets value innovation? A meta-analysis. *SSRN*. doi: 10.2139/ssrn.717562.

Damodaran, A., (2012). *Investment philosophies. Successful strategies and the investors who made them work*. New Jersey: John Wiley & Sons, Inc.

Fagerberg, J., Fosaas, M., & Sapprasert, K. (2012). Innovation: exploring the knowledge base. *Research Policy*, *41*(7). doi: 10.1016/j.respol.2012.03.008.

Goldsmith, R. E., & Foxall, G. R. (2003). The measurement of innovativeness. In L. V. Shavinina (Ed.). *The international handbook on innovation*. Amsterdam: Elsevier Science Ltd. doi: 10.1016/B978-008044198-6/50022-X.

Hall, B. H. (1999). Innovation and market value. *SSRN*. doi: 10.2139/ssrn.151912.

Hall B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations, *Rand Journal of Economics*, *36*(1).

Hirshleifer, D., Hsu, P-H., & Lic, D. (2013). Innovative efficiency and stock returns. *Journal of Financial Economics*, *107*(3). doi: 10.1016/j.jfineco.2012.09.011.

Hult, G. T. M., Hurleyb, R. F., & Knightc, G. A. (2004). Innovativeness: its antecedents and impact on business performance. *Industrial Marketing Management*, *33*(5). doi: 10.1016/j.indmarman.2003.08.015.

Jajuga, K. (2009). *Basic investment strategies*. Retrieved from: https://www.knf.gov.pl/Images/Podstawowe%20strategie%20inwestowania_tcm75-17590.pdf, (15.03.2017).

Jin, Z., Hewitt-Dundas, N. & Thompson, N. J. (2004). Innovativeness and performance: evidence from manufacturing sectors. *Journal of Strategic Marketing*, *12*(4). doi: 10.1080/0965254042000308075.

Jovanovic, B., & Macdonald G. M. (1994). The life cycle of a competitive industry. *Journal of Political Economy*, *102*(2). doi: 10.1086/261934.

Kotler, Ph. (1994). *Marketing. Analysis, planning, implementation and control*. Warsaw: Gebethner and Co.

Lev, B. (2001). *Intangibles*: *management*, *measurement and reporting*. Washington D.C.: Brookings Institution Press.

Lichtarski, J. (1999). *Basics of enterprise science*. Wroclaw: Publishing house of the Academy of Economics in Wroclaw.

Mazzucato, M. (2006). Innovation and stock prices: a review of some recent work. *Revue de l'OFCE*, *97*(5). doi: 10.3917/reof.073.0159.

Morgan, R. E., & Berthon, P. (2008). Market orientation, generative learning, innovation strategy and business performance inter-relationships in bioscience firms. *Journal of Management Studies*, 45(8). doi: 10.1111/j.1467-6486.2008.00778.x.

Nawrocki, T., & Żabka, A. (2011). Innovations activity of Polish listed companies. *Economics and Organization of Enterprises*, *11*.

Nawrocki, T. (2012). *Product innovativeness of enterprises. Assessment methodology on the example of listed companies*. Warsaw: CeDeWu.

Nawrocki, T. (2016a). Efficiency of strategy regarding investment in shares of innovative companies listed on the Warsaw Stock Exchange. *Organization Review*, *2*.

Nawrocki, T. (2016b). Risk of enterprises innovative activity in the context of their financial results. *Management Sciences*, *1*(26).

OECD/European Communities (2005). *Guidelines for collecting and interpreting technological innovation data – Oslo Manual*. Paris: OECD/European Communities.

Onag, A. O., Tepeci, M., & Başalp, A. A. (2014). Organizational learning capability and its impact on firm innovativeness. *Procedia Social and Behavioural Sciences*, *150*. doi: 10.1016/j.sbspro.2014.09.029.

Pakes, A. (1985). On patents, R&D, and the stock market rate of return. *Journal of Political Economy*, *93*(2). doi: 10.1086/261305.

Pomykalski, A. (2001). *Innovation management*. Warsaw-Lodz: PWN.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation, *Harvard Business Review*, May-June.

Prajogo, D. I. (2006). The relationship between innovation and business performance – a comparative study between manufacturing and service firms. *Knowledge and Process Management*, *13*(3). doi: 10.1002/kpm.259.

Prorokowski, L. (2014). Is investing in innovation an effective strategy in times of crisis? Some evidence from Poland. *Innovation*: *Organization & Management*, 16(1). doi: 10.5172/impp.2014.16.1.32.

Rogers, E. M. (1995). *Diffusion of innovations*. New York: Free Press.

Schumpeter, J. (1960). *Theory of economic development*. Warsaw: PWN.

Sosnowska, A. (2000). *Management of an innovative company*. Warsaw: Difin.

Świtalski, W. (2005). *Innovation and competitiveness*. Warsaw: Publishing house of the University of Warsaw.

Tellis, G. J., & Golder, P. N. (1996). First to market, first to fail? Real causes of enduring market leadership. *MIT Sloan Management Review*, *37*(2).

www.stooq.com and www.bankier.pl (22.03.2017).

www.ft.com (16.03.2017).

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Annex

Table 1. Adopted research entities, listed on the Warsaw Stock Exchange since the beginning of 2009

Company	Sector	Shares trend	R^2	r_c 2016	r_c min 2009-16	r_c max 2009-16
CD Projekt (f. Optimus Tech.)	Games Developer	upward	0,805	4689%	-20%	4689%
Asseco Business Solutions	IT	upward	0,801	861%	0%	889%
Elzab	IT	upward	0,724	576%	-53%	720%
ATM	ICT	upward	0,650	321%	-32%	425%
Macrologic (f. Macrosoft)	IT	upward	0,608	291%	0%	355%
Simple	IT	upward	0,607	92%	-37%	230%
Talex	IT	upward	0,602	124%	-59%	195%
Comarch	IT	upward	0,594	203%	-33%	230%
Betacom	IT	upward	0,488	123%	-42%	136%
Asseco Poland	IT	upward	0,478	61%	-8%	71%
LSI Software	IT	upward	0,225	90%	-44%	103%
Larq (f. Cam Media)	Media/ Marketing	variable	0,200	-14%	-86%	27%
Quantum Software	IT	variable	0,139	30%	-55%	44%
Integer.pl	Postal Services	variable	0,106	109%	-24%	1884%
CI Games (f. City Interactive)	Games Developer	variable	0,093	249%	-67%	364%
Comp	IT	variable	0,034	55%	-4%	120%
PZ Cormay	Pharmaceutical	variable	0,030	141%	-34%	1323%
Qumak	IT	variable	0,003	-32%	-32%	107%
K2 Internet	Media/Marketing	variable	0,002	16%	-37%	107%
Power Media	IT	variable	0,002	26%	-70%	32%
Wasko	ICT	variable	0,001	-42%	-42%	76%
B3System	IT	downward	0,861	-97%	-98%	82%
Bioton	Pharmaceutical	downward	0,531	-59%	-90%	55%
Unima2000	ICT	downward	0,347	36%	-33%	100%
Sygnity	IT	downward	0,344	-81%	-82%	8%

Source: own work based on investigated companies' profiles on the Financial Times website: https://www.ft.com/(29 March 2017).

Figure 1. Growing in time compounded rates of return (r_c) on investment in shares of innovative companies and the WIG index, taking into account the maximum, minimum and final values in individual periods of the analysis — general approach
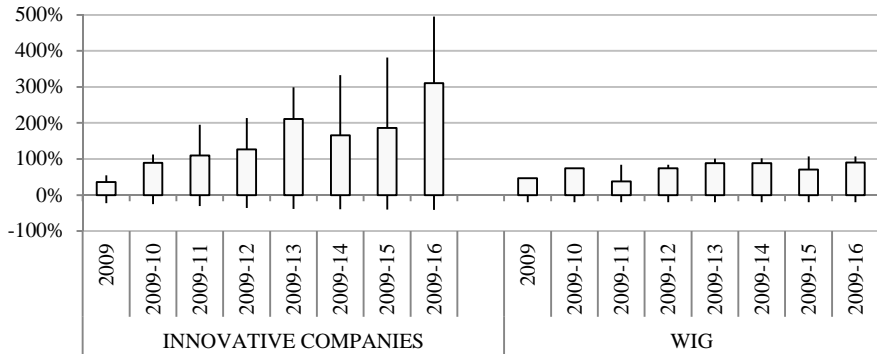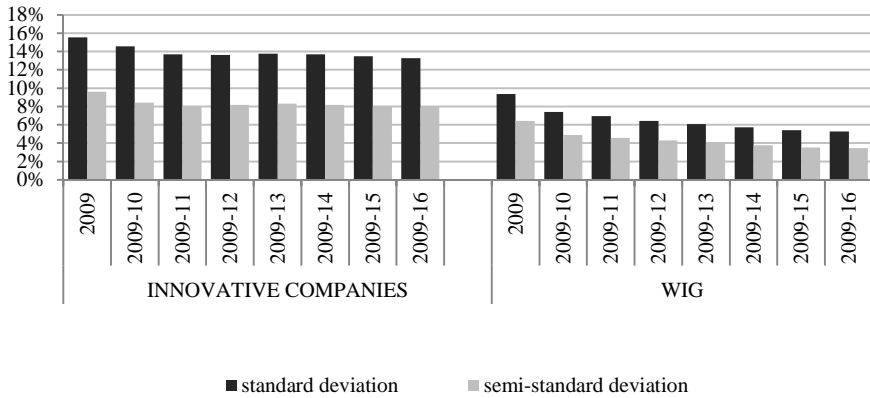
Figure 2. Average monthly rates of return ($\bar{r}$) on investment in shares of innovative companies and the WIG index in particular periods — general approach
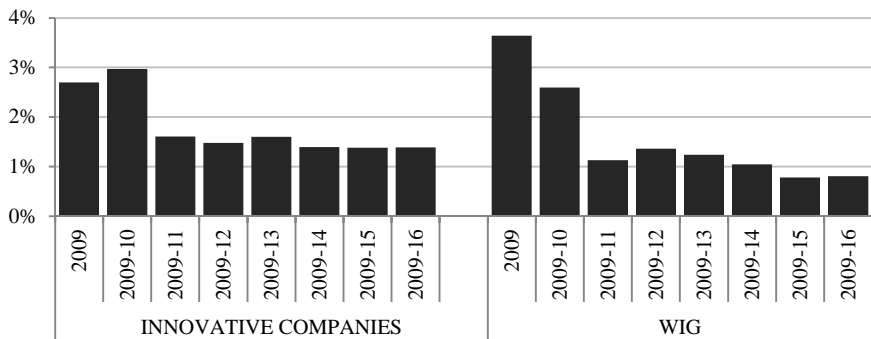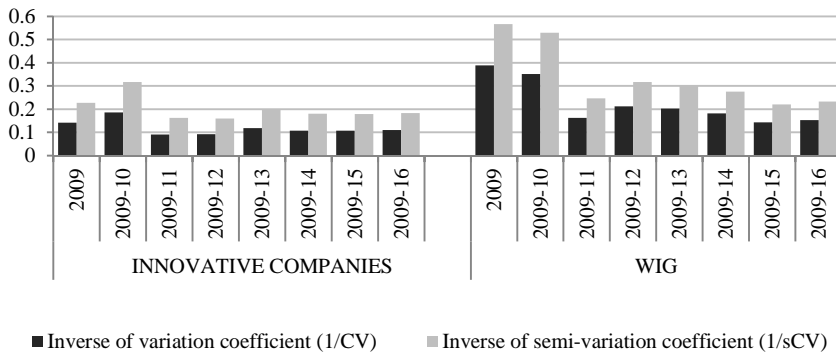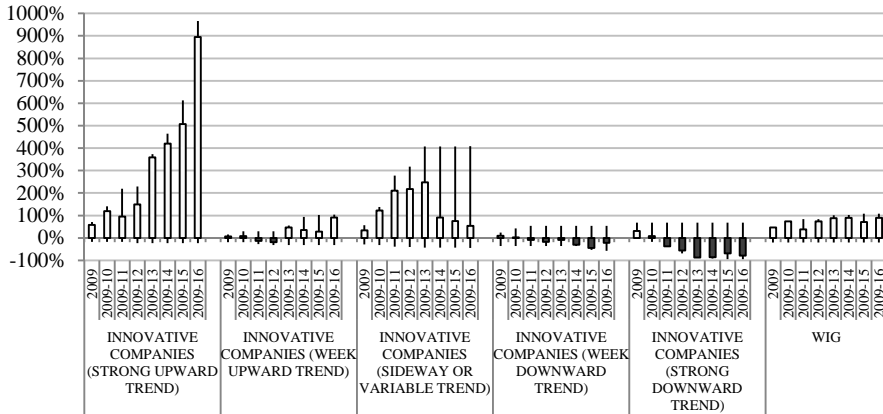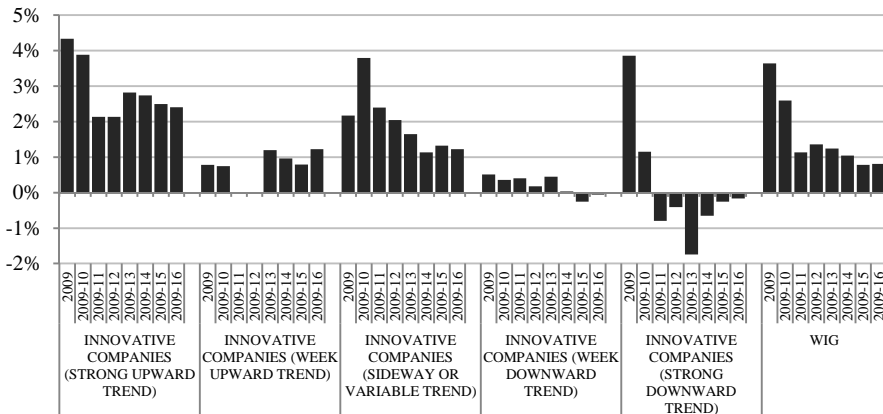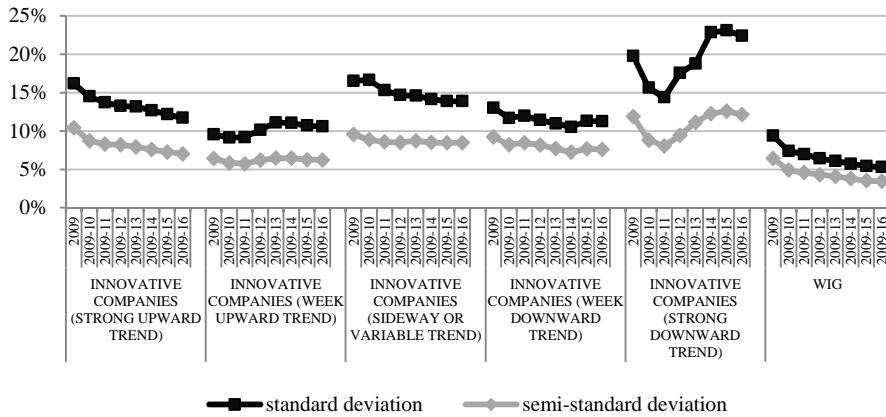
Figure 3. Standard deviation (*s*) and semi-standard deviation (*ss*) of rates of return on investment in shares of innovative companies and the WIG index in particular periods — general approach

Source: own work based on shares and indices quotations from the stooq.com portal.

Figure 4. Inverses of variation and semi-variation coefficients (*CV* and *sCV*) of rates of return on investment in shares of innovative companies and the WIG index in particular periods — general approach

Source: own work based on shares and indices quotations from the stooq.com portal.

Figure 5. Growing in time compounded rates of return (r_c) on investment in shares of innovative companies and the WIG index, taking into account the maximum, minimum and final values in individual periods of the analysis — detailed approach

Source: own work based on shares and indices quotations from the stooq.com portal.

Figure 6. Average monthly rates of return ($\bar{r}$) on investment in shares of innovative companies and the WIG index in particular periods — detailed approach

Source: own work based on shares and indices quotations from the stooq.com portal.

Figure 7. Standard deviation (*s*) and semi-standard deviation (*ss*) of rates of return on investment in shares of innovative companies and the WIG index in particular periods — detailed approach
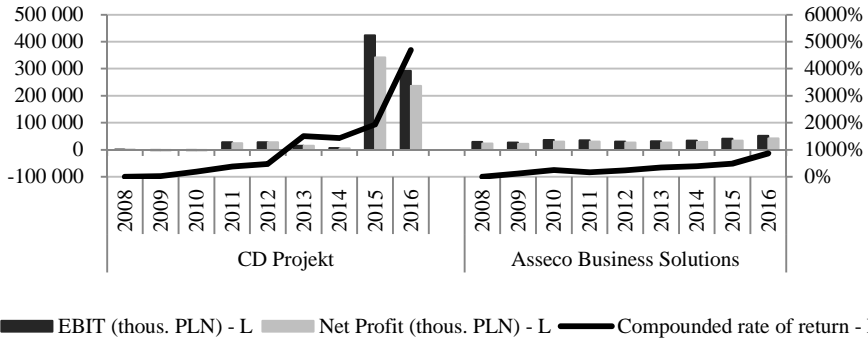
Figure 8. Inverses of variation and semi-variation coefficients (*CV* and *sCV*) of rates of return on investment in shares of innovative companies and the WIG index in particular periods — detailed approach
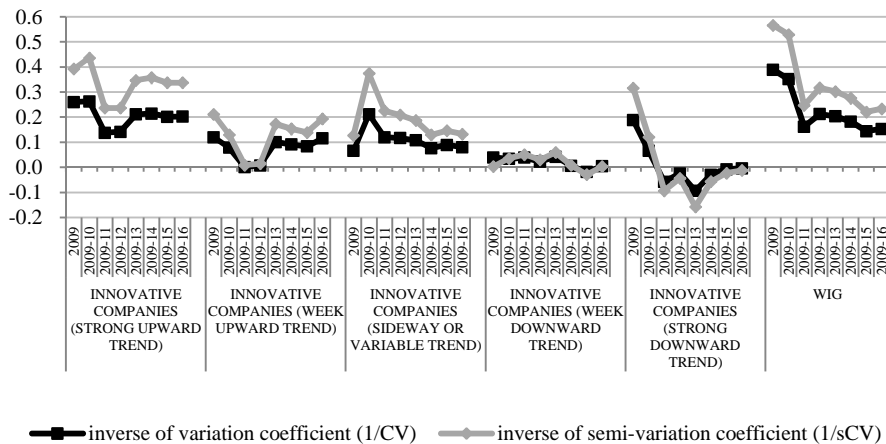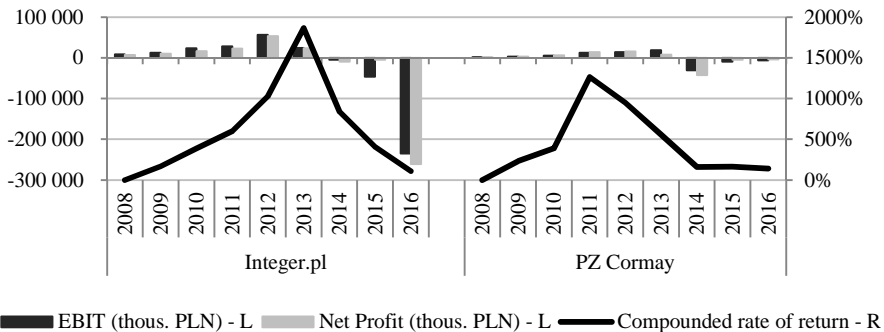
Figure 9. Growing in time compounded rates of return (r_c) on shares of two sample companies in a strong upward trend and their financial results in 2008–2016
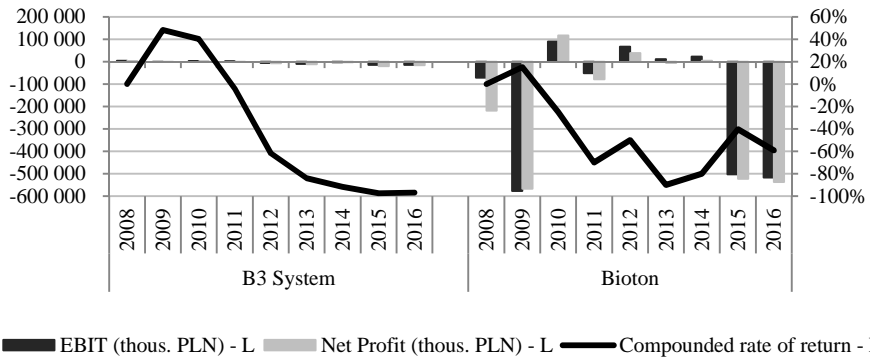

Source: own work based on shares and indices quotations from the stooq.com portal and companies financial data from the bankier.pl portal.

Figure 10. Growing in time compounded rates of return (r_c) on shares of two sample companies in a variable trend and their financial results in 2008–16

Source: own work based on shares and indices quotations from the stooq.com portal and companies financial data from the bankier.pl portal.

Figure 11. Growing in time compounded rates of return (r_c) on shares of two sample companies in a strong downward trend and their financial results in 2008–2016