DOI: https://doi.org/10.17323/j.jcfr.2073-0438.17.4.2023.5-18
JEL classification: G34, O32

Do Mergers and Acquisitions Promote R&D? The Case of European Innovation and Technology sector

Elena Rogova ✉
Doctor of Science, Professor, Saint Petersburg State University, Saint Petersburg, Russia,
e.rogova@gsom.spbu.ru, ORCID

Marina Kirichenko
Economist, MKT LLC, Moscow, Russia,
kirichenko.m.o@gmail.com, ORCID

Daria Lebedeva
Economist, JTI Russia LLC, Moscow, Russia,
dlebedeva27@gmail.com, ORCID

Abstract

Innovation efforts and R&D play a foundational role for companies seeking to further develop their products and services and secure a sufficient market share. This is especially relevant for knowledge-intensive fields, particularly for the Innovation and Technology Sector, where players are constantly challenged with adapting to its multi-faceted nature, processing large amounts of data, and rapid innovation transfer. Thus, it is important to study the factors that contribute to R&D intensity and encourage innovations in detail. The study explores the impact of M&A activity on R&D intensity and R&D spending increase of both the acquiring companies and their targets in European Union. The final sample consists of 85 companies that had implemented M&A deals in the Innovation and Technology sector of the EU between 2007 and 2021, acting as acquirers or targets in these deals. The data is collected from Refinitiv Eikon database. Subgroups are determined based on categorization established by the European Commission. These include Business support service activities, Computer programming, Data processing, Manufacturing, and Telecommunications. In addition, financial data was collected on non-merging companies for forming a control group for the analysis. Difference-in-difference and probit model estimation methods are used to analyze the effect of M&A activity on the companies involved. The results show that the R&D intensity of both acquirers and targets decreases in the post-merger period. As for R&D expenditures, they increase for acquiring companies, while the effect is the opposite for their targets. The study contributes to the literature as it, unlike other similar studies that focus mostly on one group of actors, differentiates between the effect on the innovation activity of targets and the effect on the acquirers. The results could be used to increase the knowledge of the M&A effect on innovation efforts in the Innovation and Technology sector in European countries and understanding the possible problems it could lead to.

Keywords: Innovation, Research and Development, Merger and Acquisition, R&D growth, R&D intensity, technology sector, difference-in-difference, M&A deals

For citation: Rogova E., Kirichenko M., Lebedeva D. (2023) Do Mergers and Acquisitions Promote R&D? The Case of European Innovation and Technology sector. *Journal of Corporate Finance Research.* 17(4): 5-18. https://doi.org/10.17323/j.jcfr.2073-0438.17.4.2023.5-18

Introduction

There has been a continuous debate in the scientific community as to the effect mergers and acquisitions have on the innovation efforts and R&D activity of the companies that participate in mergers and acquisitions (M&A). M&A activity peaked in Europe in 2021 to the highest level since 2009 (1893.3 bn USD) and declined in 2022 and 2023 due to the uncertainty in the business environment on the continent that led to tough monetary policies, but it remains high [1]. The discussion of mergers' impact on innovation efforts and market competition has resurfaced in the scientific community due to the recent abundance of mergers in the high-tech industries [2]. One of the illustrative examples was the merger between the drug company Pfizer and its rival, Hospira. The European Union's competition commissioner, Margrethe Vestager, said about this transaction: "We only approved the deal after Pfizer agreed to sell the European rights to an arthritis drug it was developing. One concern was that Hospira already had a competing drug on the market, and we thought Pfizer might stop work on its own drug if the deal went ahead as planned. Which would have meant less of the innovation that we depend on as patients" [2, p. 284]. Another example is the telecom merger of Telefónica Deutschland and E-Plus in Germany that also became the subject of a European Commission investigation. It was discovered that the parties were each other's 'close competitors', so the mergers would lead to the elimination of market competition between the merging parties and, therefore, to a significant price increase in all the segments including the pre-paid and the post-paid service segments. Moreover, the merger would lead to high entry barriers and limited buyer power [3]. The authors have especially started to voice their concerns since approximately 2015, when the wave of mergers associated with the largest US technological companies, namely Google, Amazon, Facebook, Apple, and Microsoft (GAFAM), was identified [4]. Later it was revealed that a significant percentage of these mergers turned to be killer acquisitions', meaning that the core product of the acquired startup was discontinued shortly after the acquisition.

The relevance of this research is determined by two main points. First, the companies in the Innovation and Technology Sector are constantly pressured to add increasingly more valuable assets, offer innovative products, and show astounding growth rates [5]. Secondly, as constant innovation and R&D spending is inherent for this sector, thorough research into how M&A activity affects innovation efforts is especially relevant [6].

Analysis of the previous research on the topic shows that the relationship between innovation efforts and M&A activity is not conclusively established. There are two polarizing opinions in the scientific community, the first one stating that M&A puts a strain on the innovation efforts of the merged entity, while the second one presents findings that in some cases suggest a positive effect on R&D of firms involved in a merger. Researchers advocating for a negative effect of M&A on innovation efforts argue that these deals seem to make managers more risk-averse, thus reducing their commitment to R&D projects, and their overall number [7], while resourses spent on the M&A itself also prevent companies from investing the expected amount of funds into the on-going R&D processes. However, the scholars who found a positive relationship between M&A and innovation speculate that the R&D intensity decreases only briefly and then picks back up, and the merged firms are also able to spread their R&D-related fixed costs across a wider variety of projects.

As for the models built using the data on M&A activity and innovation efforts indicators, J. Haucap et al. [2] built a complex model for not only measuring the effect innovation has on acquired firms and the acquirer, but also on the non-merging players that are considered to be in competition at the moment. A theoretical oligopoly model is built with heterogeneous firms as well as a patent race model based on the European Commission data on a sufficient sample of more than a hundred merger targets from 38 different product markets. The data spans almost twenty years, from 1990 to 2009. The results help establish that there is a powerful connection between mergers in the market and rivals' performance in R&D. In addition, since this connection is determined to be negative, it poses a concern to the responsible authorities, since research-intensive industries might experience holdbacks due to this fact. It is important to note that the theoretical model has shown that if the pre-merger innovation level was low, there is a chance that a merger will have a positive effect on the innovation in the industry. On the other hand, E. Cefis and O. Marsili [8] speculate that mergers promote innovation within the firm, and act as a starter in the process of becoming an active innovator. The dataset is then transferred to transition probability matrices, and a random effects discrete choice model is estimated with the purpose of determining whether innovation activity is dependent on involvement in M&A. Finally, the article by F. Szücs [9] is the first to look both at the acquirer and the target before and after the merger with an assumption that the effects on both are highly asymmetric. The author combines propensity-score matching techniques to find a similarity measure with the nearest-neighbor matching algorithm to build control groups. The effects on R&D performance of groups are later evaluated with the help of difference-in-difference estimation and with a probit model. F. Szücs [9] shows that firms acquired through a merger had lowered their R&D efforts substantially after the event took place. Interestingly, the picture is similar for acquiring firms, considering that the intensity of innovation efforts also decreases, albeit due to the sales increase and only slightly if compared to the acquired firms. This is likely because acquirers pick highly innovative firms where the main subject of their technological portfolio has not been fully exploited, which leads to an increase in marketing & sales, along with a temporary halt in R&D. Our study, thus, builds on the knowledge base collected during these studies and proposes altered and improved versions of models examining the relationship between M&A and innovation.

As most of the research performed on this topic considers only one side of the M&A deal or makes no distinction between the two, our study explores the difference between the effect on innovation activity of targets and the effect on the acquirers. In addition, the research is also centered around the Innovation and Technology Sector and its subcategories, including Business support service activities, Computer programming, Data processing, Manufacturing, and Telecommunications. Thus, the results could be used to improve the understanding of the M&A effect on R&D and innovation activities in the sector and understanding the possible costs and benefits that could arise.

The remainder of the paper is organized as follows. The first part is theoretical and is centered around the definition of key terminology and concepts used throughout the paper. Moreover, the study of the already-existing research on Innovation efforts and M&A activity in the Technology and Innovation field, its relationship, and other factors that influence R&D intensity and merger activity in the sector is performed in this section. The second part is methodological and consists of a detailed data description of data used and the empirical strategy chosen for its analysis. In the next part, the results are presented and discussed regarding hypotheses stated in the beginning. Finally, in the last part the conclusions are drawn, together with an outline of practical implications and future research opportunities.

Literature review

Mergers between companies in the Innovation and Technology market commonly cause concerns about the decline of competition on the market and the number of innovations being introduced in the market. The problem of competition and availability of technologies on the market is described in [4; 10] using the example of five largest technological companies in the market (Google, Amazon, Facebook, Apple, and Microsoft). The analysis of the past five years of these companies' general growth strategies revealed that they exhibited tremendous merger activity in the field, mostly purchasing promising technological startups. However, it is not yet completely clear whether all these mergers are carried out in line with the existing laws of antitrust authorities and, more importantly, if these regulations could even be fully applied to controversial merger cases in this new digital economy.

W. Park and R. Sonenshine [11] found that horizontal mergers lead to a decline in post-merger innovation in comparison with the level of innovation that would have prevailed had a merger not occurred, but only for the sample of mergers that were challenged by antitrust authorities. The authors claim that mergers may happen because challenged companies may cut back on duplicative R&D. At the same time, it was mentioned that the growth in both the R&D and patenting at challenged firms from the pre-merger to the post-merger period was lower than that of non-merged firms over the same period.

Hence, two dimensions of studying relationships between M&A and innovation incentives arise. First, it is the issue of how to measure innovation incentives considering the large number of studies that provide a very broad vision of innovation and its origins and results [12–14]. Second, it is important to study what motives for mergers are driven by the intention of companies to increase their competitiveness through innovation.

Measurement of innovation incentives

The existing literature can be classified into several groups based on the way of measurement of innovation efforts. The first group is comprised of patent-based studies that examine the number of patents (R&D outputs) obtained by a firm. The advantage of such methods is that patents are a direct reflection of innovation and are related only to non-standard improvements or solutions. They correlate well with other measures of innovative output, have economic significance and are comparable across industries. In [2], the number of patents per year serves as the main innovation indicator. The authors used data taken from the PATSTAT database that contains information about patent applications for the years 1978–2015 for all companies in the sample. Patent citations and technology class assigned to each patent have been extracted from the database application data. It was found that in the post-merger period the growth of patent applications decreased by approximately 46%. V. Rao et al. [15] uses a dataset that contains information about 4,444 firms from 1992 to 2008 across four high-technology industries in 45 countries. To proxy innovation activity the authors used a number of patents created by the merged firm for the first three years following the merger. According to the observed results, the number of new patents typically declines in the first year after the merger compared to the year before but increases during the next two years. The authors suppose that the reason lies in the process of adaptation to the new company structure, while expected synergy appears only in the next few years.

The second group of studies uses the company's R&D expenses (R&D inputs) to measure innovation incentives. In comparison with R&D outputs, R&D inputs are associated with the company's willingness to invest in innovation instead of their success in achieving it. G. Phillips and A. Zhdanov [16] used annual R&D expenditures scaled by sales as a measure of innovation activity of companies. They mentioned that the highest R&D activity as a percentage of sales is concentrated among firms with below-median size. F. Szücs [9] analyzes the effect of mergers on two measures of R&D inputs: the growth of R&D expenditures and R&D intensity, defined as the ratio of R&D expenditures over sales. The author states that M&A transactions entail negative R&D growth effects. It was found that R&D spending of the target firms decreased after the merger. Another key point, R&D intensity, demonstrates a similar effect. The author mentions that the ratio of research expenditures to sales steadily decreased over the period for both acquirers and target firms.

E. Cefis and O. Marsili [8] make notable contributions to the existing literature by combining two ways of measurement of innovation incentives: if the firm introduced a

technologically new or improved product, service or process, or invested in R&D, or incurred innovation expenses at any time in the three years prior to the survey. The choice to use such a broad proxy for innovation is motivated by the primary aim of the study to capture whether (in any possible way) M&A helps firms to become innovators.

Motives for mergers

Motives for innovative mergers are vast and are driven by various factors. However, it should be mentioned that they coincide with the motives of non-innovative transactions. For example, a company may be interested in improving its organizational structure, diversifying cash flows, etc. One of the driving factors is the expectation of demand growth that requires increased production capacity; hence, mergers can act as the means of such an increase [17]. The authors point out that one intention for a merger of innovative firms may be the willingness to internalize their innovation spillovers and to gain a competitive edge.

Mergers of innovative companies may allow companies to reduce costs because of the effect of scale, quickly enter new markets, redistribute resources, including those employed in R&D, increase the customer and supplier base, or increase market power. However, often the main reason for a merger in the Innovation and Technology sector is the attempt to absorb external technological capabilities to compete successfully in modern economic conditions and expand the existing knowledge base of the company.

Recent studies describe various theoretical and practical approaches that allow drawing empirical predictions about the relationship between acquisitions and R&D incentives. F. Szücs [9] provides an estimation of the probit model and difference-in-difference analysis. The results of this research support the idea that mergers have a negative effect on R&D spending during the post-merger period. Acquirers show R&D expenditure reduction as well. However, the reason for such changes could be the diversion of financial and managerial resources to restructuring after the acquisition of the company.

E. Cefis and O. Marsili [8] estimated the dynamic random effect probit model and transition probabilities for the two groups of firms: M&A active and M&A non-active to understand whether there is a difference in innovation patterns between the two main groups of firms. The results of the study suggest that if the firm has previously participated in M&A, then the probability of transition from a non-innovator to an innovator, and the probability of continuing to be an innovator significantly increases. As for the impact on firms of different sizes, in some cases small firms become innovators.

S. Chou and Y. Chu [18] measure M&A activity as one industry-level factor that is responsible for the knowledge spillovers, the variable that, in turn, encompasses the variations in the innovation activity of standalone firms in the industry. Authors show that an active M&A market positively affects idea exchange between the firms and, consequently, ensures their knowledge base growth.

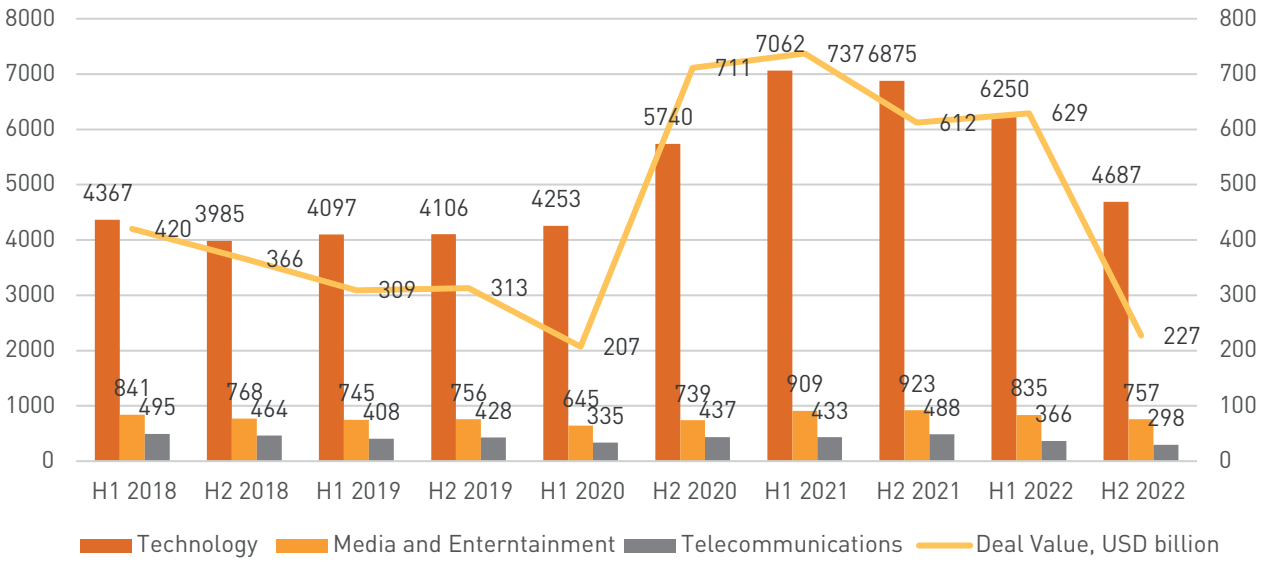
The model by K. Zhou et al. [19] considers both a down-stream firm and an up-stream firm in terms of the production chain. The model shows that a vertical merger reduces the risk premium of an innovation project. Interestingly, it is also found that the financial constraint-stock relationship is stronger in firms who pursued vertical merger integration.

G. Phillips and A. Zhdanov [16] investigate the impact of mergers and acquisitions on a firm's willingness to invest in research and development and innovations. In accordance with the theory set forth, large firms can outsource R&D investment to small ones. Later, those small firms that successfully innovate become attractive targets for acquisition, and an exit through strategic sales can be considered as the motivation to continue to spend on R&D. The paper also suggests that mergers can be a way to use innovation as a substitute strategy for the development of R&D.

Analysis of the current state and trends of the European Innovation and Technology sector

Looking at the latest overall statistics in the Innovation & Technology sector, it is apparent that M&A activity was bustling in the years leading up to the pandemic, and even certain limitations and a gap in economic activity during 2020 did not cause a major disruption to it. It can be seen from the graph at Figure 1 that the numbers have gone up in the last quarter of 2020, and the market overall seems to have rebounded. However, since the second half of 2022 M&A activities have shrunk, both in number of deals and deal value. Considering the trends in the sector, it is important to list the key points discussed in the recent publications on the topic. Firstly, as per the PwC report for 2023, abundance of new opportunities on the market led to firms exploring efficient ways to scale their operations and grow the business to compete for a significant part of the market share. Next, another characteristic of the market that is contributing to intensive M&A activity in the field is the regular disruption of other technologies, for instance, banking or healthcare, with suggestions of entirely new ways of operation and creating industries within industries, which has also led to intensive activity involving mergers and acquisitions. Finally, another key trend present in the sector is the fact that attracting funds for a new generation of companies offering lower costs and more scalable ideas is becoming increasingly easier, and models of using scaling prior to the initial public offering is thus becoming increasingly more popular [20].

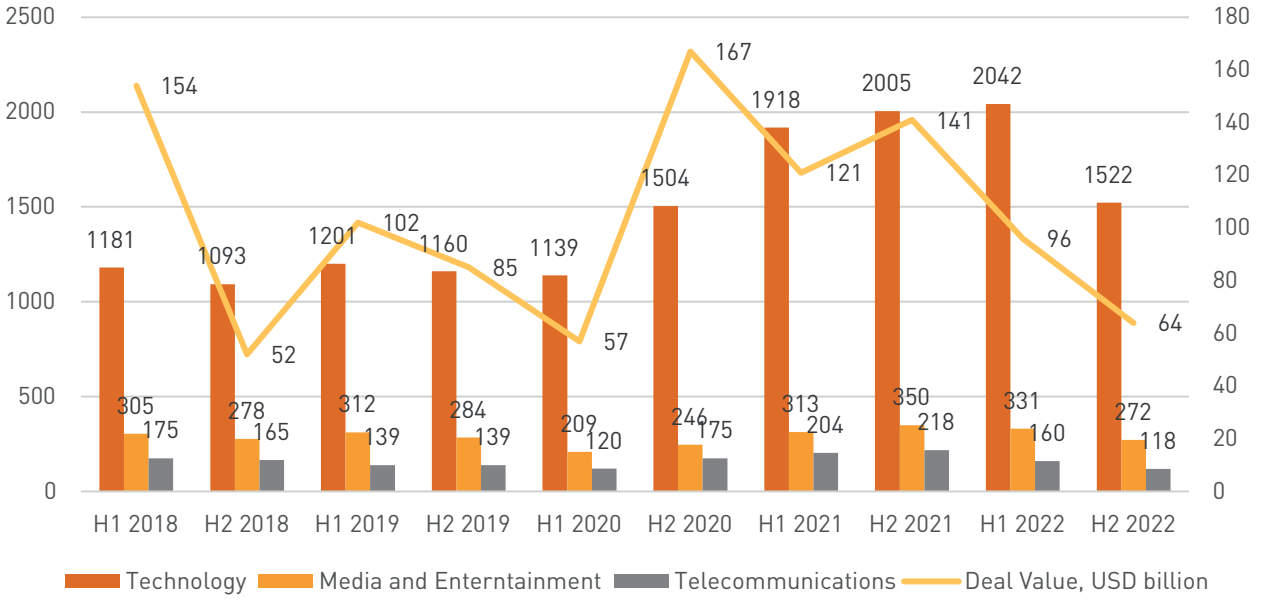
Figure 1. Number of deals and M&A deal value in the Innovation & Technology sector, 2018–2022



Source: [20].

Looking at M&A activity in the European IT sector (Figure 2), one may conclude that it mirrored global trends. Activity soared to record levels in 2021 and maintained momentum into the first half of 2022, followed by a slowdown in the latter half of 2022 that extended into early 2023 [21].

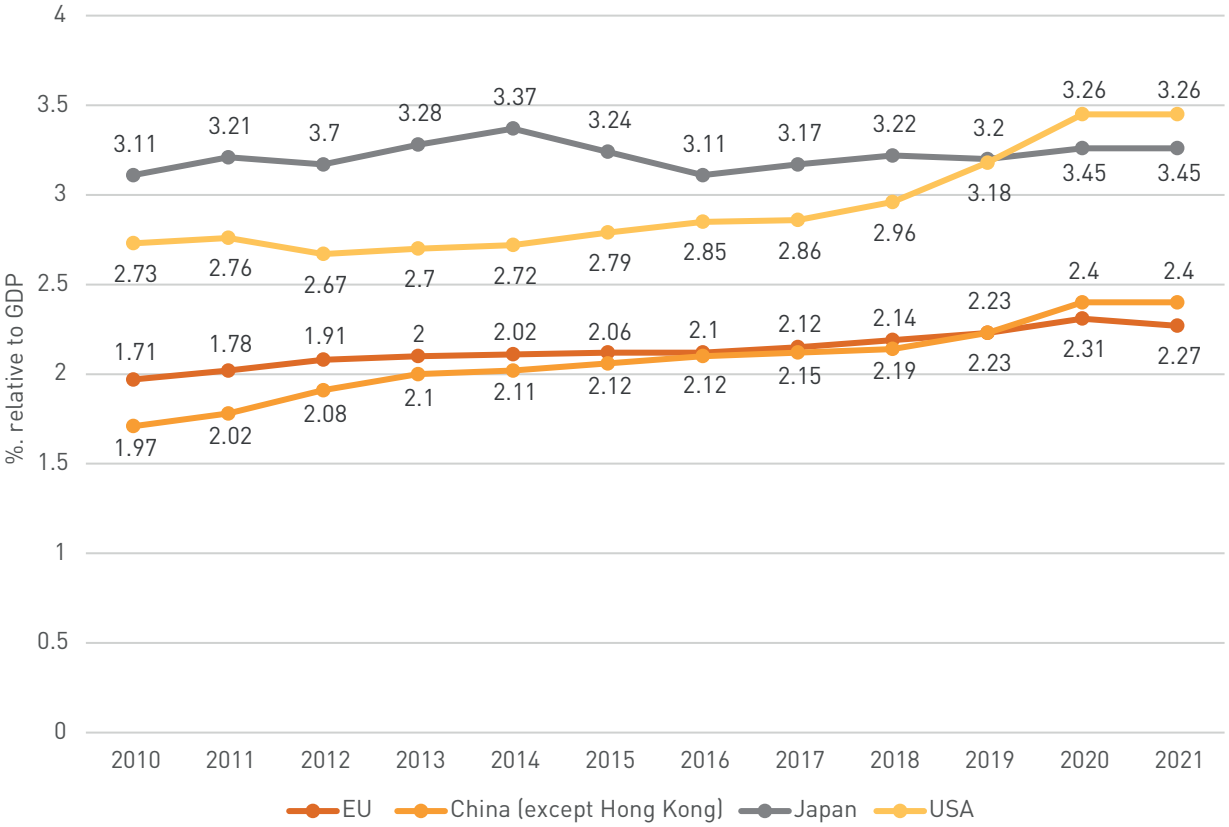
Figure 2. M&A deal value in European Innovation & Technology sector



Source: [20].

When comparing R&D expenditures in the European Union to those in other countries with developed economies, it is apparent that there is some room for growth available in the coming years. Although it is apparent that the percentage spent on R&D has been growing, there is still much to be done in terms of policies and instruments that ensure that sufficient attention is needed to this matter, so that a gap of about 2% is bridged and member states are in line with the leading developed countries (Figure 3).

Figure 3. R&D expenditures as % of country's GDP



Source: Eurostat. URL: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure

According to the Organization for Economic Co-operation and Development, as of 2021, the EU set the following as its two highest economic priorities needed for structural reform:

1) Boosting R&D and digitalization by increasing investment in R&D and promoting quicker diffusion of new tech developments.
2) Improving competition and its regulation in the sector by accounting for consumer lock-in, strong network effects, and enforcing proper big data maintenance.

Finally, looking at the percentage of people employed in the technology and knowledge-intensive sector, the percentage has remained on a rather high level for the past ten years. Throughout that time, it has also experienced a slight rise, but the overall number for the EU stayed at around 45% consistently. Therefore, it can be concluded from this graph that the sector offers many workplaces and plays a significant role in engagement of active workforce on the labor market [22].

Considering the statistics presented above, there is a significant number of M&A deals happening in the European Innovation & Technology sector, both in the amount and the deal value. It is interesting to note, however, that the percentage of R&D expenses relative to GDP has been stagnant for a few years now. Considering that the European Union has a negative trade balance in such highly innovative categories as Telecommunications, Electronics, and other high-tech goods, and the amount of M&A activity in these subcategories, it is especially vital to see whether the R&D expenses and their allocation are justified, and the value is delivered with potential sector and innovation growth considered. All in all, there is a need to determine whether intense M&A activity in the sector has any influence on R&D intensity and its growth patterns, to be able to implement the necessary regulations and initiatives to support innovation and competition in the sector in a timely manner.

Research framework and hypotheses

After analyzing the literature on the topic, a research gap for the study was identified. First, previous studies typically focused on only one side of an M&A deal (acquirers or targets), or did not differentiate between them in their analysis. In addition, several articles used short-term data available on the topic. Because it can take a longer period to restructure innovation efforts within a merged entity, this approach provides limited explanatory power. Finally, studies on the topic are focused on a vast array of industries, and the ones attracting the interest of the scientific community, and the most referenced ones, are mostly performed with data about non-R&D intensive sectors. A closer look into the innovation-driven industry is, therefore, required.

Based on the gap identified, we formulated the following hypotheses.

The first hypothesis is connected to the assumption proposed by F. Szücs [9], namely that a firm's sales would likely experience an increase after a successful acquisition, but R&D spending would not rise sufficiently, since some of expenses would be optimized through the merger of the two entities. Consequently, these assumptions would mean that as sales rise, R&D intensity decreases and R&D costs do not change. Still, after two companies merge, an increase in R&D expenses could naturally arise as their efforts and financial data for that would now be combined within the merged company. Therefore, this hypothesis should be thoroughly tested.

Hypothesis 1. The R&D intensity of the acquirer experiences a substantial decrease after the merger, but the growth of R&D spending is not negatively affected.

The second hypothesis considers the fact reported in [2], namely that the target is in a less beneficial position than the acquirer, and is thus its R&D spending and R&D intensity are likely top be negatively affected after the merger. For some time after the M&A deal, the emphasis is expected to be immediately put on integrating the target's processes into the acquirer's company both in the short and long-term, rather than on fostering new innovative outputs within the target company. The acquirer may choose to allocate dedicated R&D funds somewhere else or even dissolve intense innovation efforts of the acquired firm. However, in [23], it was found that some mergers, especially the ones that are close both sector-wise and in terms of technological processes, are likely to gain advantage in terms of R&D after merger. Since these features are also relevant for this study, the second hypothesis was formulated as follows.

Hypothesis 2. Growth of R&D spending and R&D intensity are negatively affected by the merger for target.

The third hypothesis was built based on [6]. Authors imply that innovation-centered sectors consistently show higher R&D intensity in the post-merger period. In addition, [24] reveals that knowledge-sharing and transfer of talent capabilities in terms of cybersecurity, Artificial Intelligence programming, and robotic process automation is crucial to push the sector forward. Transferring this to our data set with subcategories from the European Commission's Nomenclature of Economic Activities (NACE), it is hypothesized that out of all the categories considered during research, the Computer Programming subgroup would be the least affected due to having one the highest research intensity and innovation level compared to other subcategories. Thus, it could be considered most in need of high innovation intensity and efforts, and would be aiming to continue and preserve R&D activity even after a merger.

Hypothesis 3 R&D intensity and R&D growth of companies in the Computer Programming subgroup are influenced the least after the merger.

Methodology

Data collection and description

The data on deals evaluated in the study was collected from the European Commission (EC) database. To be selected for the research, mergers had to have value significant enough to be reported to the EC and issued a notification. The second criterion used was the sector they operated at the moment of the deal. EC database groups companies based on the European Commission's Nomenclature of Economic Activities (NACE) code [25]. Data sample is composed of companies that operate in the field of Scientific and Technical activities, Information and Telecommunication and are based in Europe. In addition, companies with more than one merger during the observed period were excluded from the sample to avoid possible bias when interpreting the results. We collected balance sheet data for these companies over the period from 2010 to 2021. In addition, the company's age was calculated, and two additional indicators were added.

1) R&D Intensity was measured as R&D expenses divided by company's revenue from business activities.
2) R&D growth is measured as a change in R&D expenses compared to the previous year. It is designed to see whether a company's spending on R&D decreased between two consecutive periods.

The data was collected using Refinitiv Eikon base and K-10 company reports. Companies without R&D data were dropped from the dataset.

The final sample consists of 85 companies. These companies were divided into subgroups determined based on categorization from the European Commission. These include Business support service activities, Computer programming, Data processing, Manufacturing, and Telecommunications (the detailed description of subgroups is provided in Appendix A). Finally, financial data was collected on non-merging companies that would later form a control group for the analysis using the same database and K-10 reports. As for the composition of the control group, it was required for the companies included to be based in the European Union, operate in the Innovation and Technology sector as per the specification used in the database, as well as report their R&D expenses and other financial information throughout the specified time. In addition, it was required for these companies not to be reported to the EU regulatory authorities (the European Commission) on the ground of participation in an M&A deal significant enough to be reported in 2007–2021. Finally, the companies that we were left with were examined to see if the parallel trend assumption would be held in each case. This assumption implies that in the absence of treatment, the difference between the test group and control group would hold constant over time.

Figure 4 and Figure 5 demonstrate the change in average R&D intensity and R&D growth for acquirers, targets, and control group approximately four years before and four years after the merger. Prior to the merger, both acquirers and targets demonstrated the same trend towards a slight decrease in the R&D intensity with small fluctuations.

Figure 4. Dynamics of R&D Intensity over a 4-year period before and after the deal

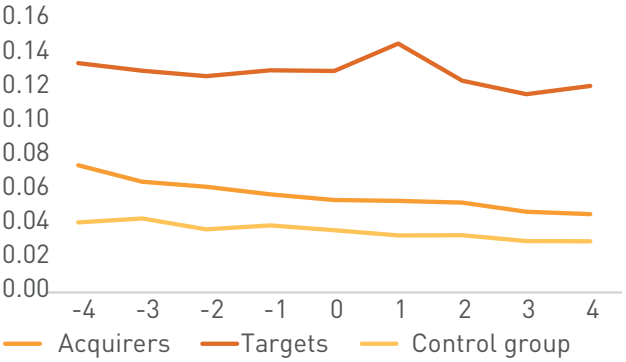
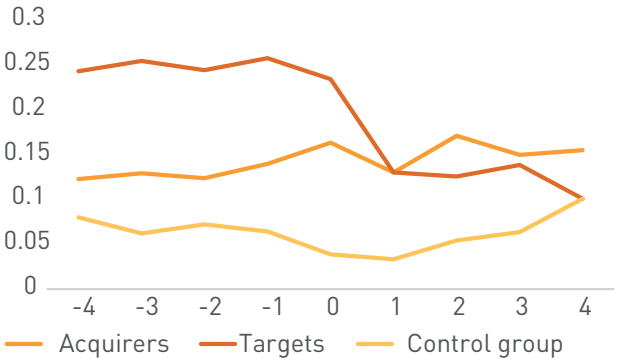


Figure 5. R&D growth over a 4-year period before and after the deal



After the merger (year 0), the dynamics of the two groups of companies remains the same: acquirers have been showing a steady decrease over the next 4 years, approximately 16% for the whole period, while the R&D intensity of targets has almost the same values. Compared to the test group, R&D intensity of the control group is much higher; the difference is approximately 50%. However, the graph does not demonstrate any significant fluctuations except for two years, when the value increased from 0.14 to 0.16.

As for the R&D growth trend, a sharp decrease in growth by 44% for targets in the first years after the mergers can be clearly seen, while later on growth became more stable. Acquirers demonstrate fluctuations over the whole period; however, a positive trend can be observed with a 26% average growth. The R&D growth of acquirers is caused by the transfer of R&D assets from the targets' to the acquirers' books after the merger. As for the control group, the graphic has a U-shaped form: after a sustained decline with the lowest point of 3.3%, the number began to grow.

Summary statistics for both pre-merger and post-merger periods are listed in Table 1.

Table 1. Average values of firm-level variables for control and treatment groups before and after the M&A deal

Variable	Acquirers		Targets		Control group	
	Before	After	Before	After	Before	After
R&D intensity	0.07	0.04	0.04	0.03	0.13	0.13
R&D growth	0.13	0.15	0.25	0.12	0.07	0.06
Total assets	68.31	93.13	26.23	29.28	51.69	72.92
Total debt	18.82	31.48	48.07	68.23	22.19	37.31
Revenues	40.04	49.12	25.45	26.64	26.66	33.91
Net income	6.25	7.31	1.61	1.59	1.68	2.91

Based on Table 1, it can be concluded that acquirers are characterized as firms with higher net income, which possess a greater number of assets, while targets show a negative debt-to-assets ratio and are less profitable. In addition, we can see that the control group's indicators of R&D intensity and R&D growth are much higher than those of the treatment group. It can be speculated, therefore, that the treatment group might use its merger activity as a means of acquiring that R&D and bridging the innovation gap.

To receive an additional insight into the data collected and its characteristics, probit models were constructed. We estimate the binary choice model where the dependent variable equals 1 if the firm was an acquirer, and 0 if the firm was a target. R&D intensity, R&D growth, total debt, net income, total assets, and age have been added as explanatory variables. For these variables we took pre-merger data, as it could potentially affect both the decision to merge and companies' future R&D efforts. We expected that the model may include a U-shaped or inverse U-shaped relationship with the role of the firm in a merger. To account for possible non-linearities in assets and age, we also include squared total assets and age. The model was estimated with random effects since the outcome does not vary over time for companies. The probit model was chosen based on the Akaike and Bayesian information criteria.

Table 2 presents the results after the calculation of margins for the estimated model. Acquirers on average are more R&D-intensive compared to non-acquiring companies. As was shown previously, targets were characterized by a staggering average R&D growth of more than 20% pre-merger. This could indicate that targets are usually striving to become innovation-intensive, and acquirers, seeing that they have a lower level of R&D intensity, might consider M&A as a new way of attaining new technology or know-how, as well as receiving a potential competitive advantage. A negative coefficient for the square of age shows that very young or very old companies are less likely to be acquirers than middle-aged companies. The positive coefficients of squares of total assets show that acquirers are usually companies with a very high or very small value of total assets.

Table 2. The results of probit model estimation

Variable	Coefficient
R&D intensity	.566*
	(.809)
R&D growth	–.130*
	(.003)
Total Debt	–.022*
	(.019)
Net income	.002
	(.046)
Total assets	1.292***
	(.342)
Total assets2	.044***
	(.023)
Age	.008***
	(.010)
Age2	–.00004***
	(.000)
Wald chi2	64.75

***, **, * denote the level of significance of 1%, 5% and 10%, respectively.

Research approach

Based on [9], the difference-in-difference approach was chosen to examine the effect of mergers on incentives of firms to innovate. The key idea is to compare changes in outcomes of the two groups over time: the first group is treated in a specific way; while the control group is not treated. The basic equation for the estimation of treatment effect presented is as follows:

$$y_{it} = \gamma + \gamma_i TREAT_i + \gamma_i POST_t + \beta TREAT_i \times POST_t + u_{it}, \quad (1)$$

where *TREATi* is a dummy variable of being treated or not; *POSTi* is a dummy variable for the post-treatment effect, and *TREATi* × *POSTi* is the treatment effect.

Therefore, the Difference-in-difference estimator can be defined in the following way:

$$\hat{\beta} = (\bar{Y}_2^T - \bar{Y}_2^C) - (\bar{Y}_1^T - \bar{Y}_1^C), \quad (2)$$

where $(\bar{Y}_2^T - \bar{Y}_2^C)$ is the difference in average outcomes between treated and untreated groups after the treatment, while $\bar{Y}_1^T - \bar{Y}_1^C$ is the difference in average outcomes between treated and untreated groups before the treatment.

The assumption of the basic model is that there are only two periods present. The first one takes place before the treatment, and the second one happens after. As the focus of the research is to find whether there is a change in R&D expenditures between these two periods, the dependent variable is constructed as the difference between the post-treatment and pre-treatment period [26]:

$$X_{post} - X_{pre} = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 X + \varepsilon. \quad (3)$$

To attain the $X_{ù}$ indicator, the mean of either R&D growth or R&D intensity in the four years leading up to the year when the M&A deal was registered, was calculated. Similarly, the X_{post} is the mean of the four years after the year M&A took place. D_1 here is a categorical variable that equals 1 if the company did not participate in M&A at all during the observed period; 2 if the company was an acquirer in an M&A deal, and 3 if the company was a target. D_2 is a categorical variable indicating a company's subcategory from the EC categorization. X is the set of control variables including financial indicators such as Total Assets, Debt, and Net Income.

However, some bias needed to be eliminated, in particular, regression to the mean. Thus, an additional variable $X_{ù}$ was added to the model to account for the difference between the companies that was already present in the beginning of the observed period. The reason behind this addition is the assumption that the initial value of R&D intensity in the companies not involved in the M&A as opposed to the companies involved, was already substantially different from the beginning. A correlation between $X_{ù}$ and the $_1$ variable indicates if the company has participated in M&A, then the first regression built would produce a biased result. The regression with an added variable is presented below:

$$X_{post} - X_{pre} = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 X_{pre} + \beta_4 X + \varepsilon. \quad (4)$$

The D_1 variable indicates if participating on either side of the M&A deal really affects the performance of the company comparing to its initial performance in the pre-deal period. Hence, the true effect of the M&A deal on R&D intensity and growth is apparent.

While the basic difference-in-difference model assumes that there are only two time periods, in practice situations may arise when treated and untreated groups have different trends in the average of the outcome variable. Additional challenges arise in the case of extended time periods when treatments occur at different times. The basic equation (1) cannot be estimated in this case because the post-period dummy is not defined for control observations. To solve the problem of time-varying treatment effects, researchers usually apply the two-way fixed-effect model [27] as follows:

$$\gamma_{it} = \alpha_i + \alpha_t + \beta D_{it} + \varepsilon_{it}, \quad (5)$$

where α_i is a dummy-variable for cross-sectional units, α_t stands for time periods, and D_{it} is a treatment dummy.

The estimated model is presented below:

$$\gamma_{it} = \alpha_i + \alpha_t + \beta_0 D_{it} A_i + \beta\ Ind_i + \beta\ X_{it} + \varepsilon_{it}. \quad (6)$$

Models were constructed based on the dependent variables (γ_{it}) discussed above: R&D intensity and growth of R&D spending. Control variables (X_{it}) included various financial indicators, such as Total debt, Total assets, Net income, EBIT, as well as company's age and its subcategory in the EC categorization ($ù_{\ i}$). Dummy variable D_{it} indicates the

treatment effect, but as treatments occur at different times, the variable was equal to 1 for the post-merger period and 0 for pre-merger period. A_i represents the dummy-variable that is equal 1 if company is an acquirer, and 0 if the company is a target. The interaction of these two variables helps to test our hypothesis about the impact both on acquirers and targets in the pre–merger and post–merger periods. In contrast to the basic model, the control group has not been included in the model because groups (before and after merger periods) serve as controls for each other during periods when their treatment status does not change.

The timeline within the data set was designed to track the evolution of innovation efforts through the years, before and after the merger. For this purpose, a set of dummy variables was created to indicate how far removed from the merger deal the currently examined year is.

Results and discussion

The first models estimated used the econometric specifications (3) and (4) discussed above. Table 3 presents the results of cross-section data models.

Table 3. Cross-section data model estimation results

Variable	Model 1		Model 2	
	R&D intensity	R&D growth	R&D intensity	R&D growth
Treated (Acquirer)	–0.375*** (0.011)	1.485** (0.069)	–0.437*** (0.009)	0.568*** (0.061)
Treated (Target)	–0.340*** (0.011)	–1.223** (0.069)	–0.437*** (0.011)	–1.382*** (0.059)
Initial value			–2.274*** (0.065)	–0.808*** (0.129)
Business support	–0.145** (0.013)	–0.465 (0.087)	0.012*** (.013)	–0.358 (0.074)
Computer programming	–.012* (.012)	–0.493* (0.080)	0.021** (0.011)	0.118** (0.069)
Data processing	–0.040 (.013)	0.461* (0.091)	–0.024 (0.013)	0.844** (0.078)
Manufacturing	0.109 (0.013)	–0.997** (0.084)	0.012** (0.012)	0.149 (0.074)
Revenue	0.081 (0.027)	–0.094 (0.018)	0.049* (0.025)	–0.049 (0.015)
Total Debt	0.535** (0.062)	0.025** (0.004)	0.265* (.058)	0.049* (0.003)
Total assets	–0.015 (0.027)	–0.022* (0.017)	–0.394 (0.025)	0.015** (0.015)
Adjusted R-squared	0.271	0.212	0.543	0.496

***, **, * denote the level of significance of 1%, 5% and 10% respectively.

Examining the coefficients for the first and second model in terms of R&D intensity, we can observe that the indicator for the acquirer and the target went up from –0.375 to –0.437 and from –0.340 to –0.437 respectively, which shows that controlling for the initial value helped in determining that the effect for M&A participants becomes more noticeable. As for the R&D growth of the acquirer, there is a noticeable decline from 1.485 to 0.568, however, the effect for target becomes even more pronounced with coefficient changing from –1.223 to –1.382. This could mean that M&A did not have a major effect on the R&D growth of the acquirer, but it is attributed to the decrease in the R&D activity of the target.

Based on the given outputs and considering the hypotheses formulated at the beginning, only some predictions were confirmed during the analysis. The first one stated that the R&D intensity of the acquirer experienced a substantial decrease after the merger, but growth of R&D spending is not negatively affected. It was confirmed, as R&D intensity is indeed negatively affected by a merger. On the other

hand, growth of R&D spending demonstrates positive dynamics over time. The second hypothesis about the growth of R&D spending and R&D intensity being negatively affected by the merger for the target, was partially confirmed. R&D spending has indeed declined after M&A, however, R&D intensity showed growth. The final hypothesis that stated that R&D intensity and R&D growth of companies in the Computer Programming group are least impacted after the merger was rejected. This was confirmed for the R&D growth model, however, the least affected group in terms of R&D intensity was Manufacturing.

Next, the two-way fixed effects model was estimated (Table 4). The dependent variable is the interaction between two dummies. It shows that a target's R&D intensity and R&D growth are negatively affected by mergers. The coefficients are negative and statistically significant, and the findings correspond to the models estimated with cross-sectional data. The effect on R&D spending is much more pronounced for targets, with a 0.336 average decrease compared to a 0.168 average increase for acquirers. At the same time, the positive coefficient for R&D growth for acquirers demonstrates that the incentive to sustain research activities continues to grow, while targets' innovative programs seem to diminish in the post-merger period. It was discovered that R&D intensity was the most affected in the Business support activities category, while the category least affected by M&A is Data processing. In terms of R&D growth, the least affected category is Computer programming, which corresponds to the previous model. Manufacturing demonstrates the greatest exposure to the impact of R&D growth changes.

Table 4. Panel data model estimation results

Variable	R&D intensity	R&D growth
Treated (Acquirer)	–0.016**	0.168**
	(0.016)	(0.073)
Treated (Target)	–0.005***	–0.336*
	(0.003)	(0.054)
Business support	0.118**	–0.077
	(0.049)	(0.188)
Computer programming	0.068*	0.045
	(0.021)	(0.085)
Data processing	0.048**	0.074
	(0.023)	(0.089)
Manufacturing	0.051*	0.101**
	(0.019)	(0.080)
Net income	–0.003*	0.005
	(0.001)	(0.024)
Total Debt	0.001	0.005**
	(0.001)	(0.014)
Total assets	0.005**	–0.016
	(0.003)	(0.035)
EBIT	0.002**	0.076**
	(0.001)	(0.033)
Age	0.004	–0.001*
	(0.001)	(0.000)
F-statistics	40.35	33.01

***, **, * denote the level of significance of 1%, 5% and 10%, respectively.

If we evaluate these results as compared to the previous studies on the topic, there are some noticeable differences. P. Desyllas and A. Hughes [23] find that R&D intensity of high technology companies only decreases in the first year after the merger, but then stabilizes and starts to steadily climb up over a three-year window after the merger, R&D productivity is also found to increase simultaneously. While our findings contradict these of the above-mentioned authors, our results are in line with other authors' research on the topic, namely [2], where a negative effect on R&D intensity in the post-merger periods was revealed, not only for firms participating in M&A activity but also for their competitors in possession of overlapping technologies. F. Szücs [9] also confirms that R&D intensity of both the acquirer and the target faces a decline post-merger. Finally, [4] discovered that M&A activity of large players in the Innovation and Technology Sector is destructive for innovation activity and R&D growth of target firms, and in some cases even contributes to the discontinuation of its core product. In conclusion, results seem to mainly agree with the latest research on the topic, however, there are several contradictions, perhaps due to a difference in measurement techniques and R&D metrics under evaluation that are chosen for each study.

Possible limitations of the study include its limited geographical scope as the study was performed only on the data from companies based in the European Union, and the R&D intensity and growth patterns could significantly differ from region to region. Cross-border deals, i.e., those that had been completed between companies in EU and companies from other regions also were not considered.

Another limitation is the relatively small number of firms that report R&D expenditures in their financial data. As with all the observations for which R&D expenditures are not recorded or must be dropped, the sample size had decreased by a significant percentage. This is especially relevant for target firms, as some of them were still considered small or medium-sized enterprises that do not publish their financial data as frequently as larger enterprises. We also dropped data companies that performed several acquisitions during the observed period; however, it could be interesting to investigate how serial acquisitions affect the acquirers' R&D efforts.

Finally, only the R&D costs were measured during the study, serving as a representation of the R&D input. It is not yet clear how it correlates with the R&D output of companies, and if there is, perhaps, a different trend will be revealed when comparing it with the input.

Conclusion

In this paper, the effects of M&A activity on R&D intensity and R&D growth of both companies acting as acquirers and targets were studied. It was found that R&D intensity is negatively impacted in the post-merger period for both the target and the acquirer. R&D growth experiences a decrease after the M&A for the target, but not the acquirer. Based on the analysis of other studies on the topic, the pattern here is somewhat compatible to innovation-related acquisitions, where the acquiring firm is looking for an acquisition of an already developed technology, instead of building one in-house. Since target firms are characterized by a much higher percentage of R&D growth pre-merger, which decreases by half after the deal, this could be interpreted as a threat to its potential of being a continuously innovative enterprise.

Considering the possible implications here, since most merger targets are firms with high R&D intensity, it is important to establish controls to ensure that these innovation efforts are not disrupted while these firms engage in M&A activity. Looking at the financial data, it is important to note that target firms had a considerable amount of debt in the pre-merger period, and after the merger, the debt has increased by about one third, while the assets increased only slightly, by approximately 15%. In the meantime, the acquirers showed a considerable growth in assets, net income, and revenue, with the latter increasing by more than 20%. The assumption here is that since R&D intensity is the ratio of R&D expenses to revenue from Business Activities, and that this ratio seems to be decreasing for both sides of the M&A activity, while R&D growth patterns differ between acquirers and targets, it is explained by a noticeable rise in revenue for the acquirers, and a decline in R&D spending for the target group. A negative R&D growth effect is a worrying sign that was present in cases related to targets, and, considering that these targets operate in a highly innovative field, this fact should be examined by competition authorities when designing methods of supporting the competitive significance of target firms. A growing amount of debt and stagnating or severely decreasing R&D activity can cause the target's core product or service to be dissolved into the acquirer's assets or be discontinued. This could in turn lead to the elimination of highly innovative market players, which is destructive to the competition within the sector, and as competition is one of the driving forces in sustaining stable growth in the sector and contributing to the customers' welfare, it is better to encourage careful supervision by competition authorities.

Considering future research opportunities, only the R&D input was measured during the study. Consequently, as a continuation of the study, it would be possible to now focus on the R&D output of firms (patents, innovative products, know-how technics, etc.) to determine if there is a correlation between input and output, as well as R&D intensity and growth. Another possible direction of research here is the observation of how related target and acquirer really are. The relatedness could be measured either by technology produced by both of them and the market in which they operate. This would provide a potential opportunity for discovering whether the relatedness of companies is a potential threat to innovation, or, on the contrary, conducive to knowledge transfer.

References

1. Pitchbook Global M&A Report Q3 2023. 2023. URL: https://pitchbook.com/news/reports/q32-2023-global-ma-report (accessed on 03.07.2023)
2. Haucap J., Rasch A., Stiebale J. How mergers affect innovation: Theory and evidence. *International Journal of Industrial Organization.* 2019;63:283-325. https://doi.org/10.1016/j.ijindorg.2018.10.003
3. Tyagi K. *Promoting Competition in Innovation Through Merger Control in the ICT Sector: A Comparative and Interdisciplinary Study*. Springer; 2019. 360 p.
4. Gautier A., Lamesch J. Mergers in the digital economy. *Information Economics and Policy*, 2021;54:100890. https://doi.org/10.1016/j.infoecopol.2020.100890
5. Argentesi E., Buccirossi P., Calvano E., et al. Merger policy in digital markets: An ex-post assessment. *Journal of Competition Law and Economics*. 2021;17(1):95-140. https://doi.org/10.1093/joclec/nhaa020
6. Christofi M., Vrontis D., Thrassou A., et al. Triggering technological innovation through cross-border mergers and acquisitions: A micro-foundational perspective. *Technological Forecasting and Social Change.* 2019;146:148-166. https://doi.org/10.1016/j.techfore.2019.05.026
7. Kern B. R., Dewenter R., Kerber, W. Empirical Analysis of the Assessment of Innovation Effects in U.S. Merger Cases. *Journal of Industry, Competition and Trade*. 2016;16:373-402. https://doi.org/10.1007/s10842-016-0225-0
8. Cefis E., Marsili O. Crossing the innovation threshold through mergers and acquisitions. *Research Policy*. 2015;44(3):698-710. https://doi.org/10.1016/j.respol.2014.10.010
9. Szücs F. M&A and R&D: Asymmetric Effects on acquirers and targets. *Research Policy.* 2014;43(7):1264-1273. https://doi.org/10.1016/j.respol.2014.03.007

10. Motta M., Peitz M. Big tech mergers. *Information Economics and Policy.* 2021;54:100868. https://doi.org/10.1016/j.infoecopol.2020.100868

11. Park W.G., Sonenshine R. Impact of Horizontal Mergers on Research & Development and Patenting: Evidence from Merger Challenges in the U.S. *Journal of Industry, Competition and Trade.* 2012;12(1):143-167. https://doi.org/10.1007/s10842-011-0119-0

12. Gopalakrishnan S., Damanpourb F. Patterns of generation and adoption of innovation in organizations: Contingency models of innovation attributes. *Journal of Engineering and technology management.* 1994;11:95-116. https://doi.org/10.1016/0923-4748(94)90001-9

13. Subramanian A., Nilakanta S. Organizational Innovativeness: Exploring the Relationship Between Organizational Determinants of Innovation, Types of Innovations, and Measures of Organizational Performance. *Omega.* 1996;24(6):631-647. https://doi.org/10.1016/S0305-0483(96)00031-X

14. Tushman M.L., Anderson P. Technological discontinuities and organizational environments. *Administrative Science Quarterly.* 1986;31(3):439-465. https://doi.org/10.2307/2392832

15. Rao V.R., Yu Y., Umashankar N. Anticipated vs. Actual Synergy in Merger Partner Selection and Post-Merger Innovation. *Marketing Science.* 2016;35(6):934–952. https://doi.org/10.1287/mksc.2016.0978

16. Phillips G.M., Zhdanov A. R&D and the Incentives from Merger and Acquisition Activity. *The Review of Financial Studies.* 2013;26(1):34–78. https://doi.org/10.1093/rfs/hhs109

17. Entezarkheir M., Moshiri S. Innovation spillover and merger decisions. *Empirical Economics.* 2021;61(5):2419–2448. https://doi.org/10.1007/s00181-020-01973-6

18. Chou S.C., Chu Y.F. Innovations and earnings non-synchronicity: evidence from industry M&A activities. *Accounting & Finance.* 2022;62(1):337–367. https://doi.org/10.1111/acfi.12792

19. Zhou K., Yan R., Liu Y. Vertical merger, R&D collaboration and innovation. *The European Journal of Finance.* 2019;25(14):1289–1308. https://doi.org/10.1080/1351847X.2019.1589551

20. *Global M&A Trends in Technology, Media & Telecommunications: 2023 Outlook.* PWC, 2023. URL: https://www.pwc.com/gx/en/services/deals/trends/2023/telecommunications-media-technology.html

21. The regional perspective. 2023 M&A report. BCG. October 26, 2023. URL: https://www.bcg.com/publications/2023/regional-perspective-on-m-and-a-market-trends

22. Science, technology and innovation – Overview. Eurostat Statistical, European Commission, Luxembourg. URL: https://ec.europa.eu/eurostat/web/science-technology-innovation

23. Desyllas P., Hughes A. Do high technology acquirers become more innovative? *Research Policy.* 2010; 39(8): 1105–1121. https://doi.org/10.1016/j.respol.2010.05.005

24. 2022 Technology Industry Outlook. Deloitte, 2022. URL: https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/technology-industry-outlook.html (accessed on 03.07.2023)

25. *NACE Rev. 2. Statistical classification of economic activities in the European Community.* Luxembourg: Office for Official Publications of the European Communities, 2013. URL: https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF (accessed on 03.07.2023)

26. Ball L., Sheridan N. Does inflation targeting matter? In: The Inflation-Targeting Debate. In: Bernanke B.S., Woodford M., eds. *The Inflation-Targeting Debate.* University of Chicago Press; 2005:249-276. URL: http://www.nber.org/chapters/c9561

27. Goodman-Bacon A. Difference-in-differences with variation in treatment timing. *Journal of Econometrics.* 2021; 225(2): 254-277. https://doi.org/10.1016/j.jeconom.2021.03.014

Appendix A

Definition of subgroups in the Innovation and Technology Sector

Subcategory	Definition
Computer programming	Managing local systems and operation of computer networks and/or customer data processing enterprises; providing expertise in the field of information technology: writing, modifying, testing and providing computer software support; planning and design of computer systems, various services related to computer equipment support, software and communication technologies; and other professional and technical computer activities
Business support service activities	Maintaining hardware and software on demand; provision of computer consultations and software for IT and business personnel, configurating specific business-tailored solutions; performing disaster recovery services and check-ups; installation of personal computers; software installation services
Data processing	Providing necessary infrastructure for hosting, data processing services, databases and related activities, as well as providing search engines and other outlets for the data maintenance on the Internet
Manufacturing	Production of equipment necessary for stable delivery of services in the information and communication technology (ICT) field, i.e., computers, telecommunication equipment, consumer electronics, non-individualized software
Telecommunications	Providing services related to telecommunications and related services (transmission of data, voice, recordings, text, sound, and video)

Source: [25].

Contribution of the authors: the authors contributed equally to this article.

The authors declare no conflicts of interests.

The article **was submitted** 06.10.2023; **approved after reviewing** 08.11.2023; **accepted for publication** 30.11.2023.