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Influence of Top Management Characteristics on the Innovative Development of the World's Top Companies in the Pharmaceutical Industry

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Abstract. Changes in the pharmaceutical industry lead to the need for detailed consideration of the issues of stimulating innovation, where top management largely determines the company's strategy of innovative development. Thus, it is important to study which characteristics of top management's human capital influence the innovation activity of pharmaceutical companies in creating new products. This article tests a hypothesis that the success of a pharmaceutical company's drug portfolio depends on ideas arising from basic research and large-scale commercialization that recoup high development costs, which in turn are influenced by the personal characteristics of top managers. The study is an econometric analysis of the impact of human capital elements, represented by top management characteristics, on the innovation activity of major pharmaceutical companies, where two models on patents and R&D were tested using panel regression. The models were tested using data from the world's top 100 pharmaceutical companies from 2010 to 2022. The results made it possible to compile an average portrait of the top manager of the largest pharmaceutical companies. The analysis has shown that professional experience, age, as well as a job-specific degree can have a significant impact on innovation activity. The study contributes to the literature as it makes it possible to predict the innovation strategy of pharmaceutical companies through an average portrait of the top manager. The proposed model will reduce the number of failures of innovative directions, optimize the time period of commercialization of new drug development projects and can be used in other research studies.

Key words: innovative activity; R&D; patent; top management; human capital.

JEL I11, J24, O3, O15

1. Introduction

Human capital and innovation activity are closely related. Human capital represents the knowledge, skills, and experience that people have. Innovation activity, in turn, is the creation of new products, processes and services that lead to improvements in people's lives. People with high levels of human capital, such as education, work experience and creative thinking abilities, are often the drivers of innovation activity. They can come up with new ideas and approaches and develop and implement new technologies and processes.

In addition, companies that invest in the human capital development of their employees often have greater innovation activity. Such companies can provide their employees with training and various development programs that allow them to improve their skills and knowledge and stimulate their creativity.

The innovation activity of a company changes under the influence of managerial decisions of top management. Innovation activity of companies operating in the same industry will differ significantly under the condition of different management teams. In order to adapt to the competitive environment and improve operational performance, companies must consider the impact of top management's human capital on the company's performance. Innovation activity is a key role for pharmaceutical companies. They have to constantly look for new treatments, develop new drugs and technologies to improve people's health and quality of life. Innovation activity also helps pharmaceutical companies stay competitive in the market and retain their position. Without innovation, pharmaceutical companies will not be able to grow and continue in the future.

Companies also need highly skilled people who can develop new drugs and technologies and conduct research and clinical trials. In addition, pharmaceutical companies must continually train their employees and keep up with industry developments. The more skilled the specialists in a company, the more successful its innovation and competitiveness in the market will be.

We hypothesize that in the pharmaceutical industry, innovation activity, which is the most important factor for survival in a competitive environment, also depends on the characteristics of top management's human capital, namely age, education and work experience.

The main purpose of this paper is to examine, how investors, managers, and analysts can use the model for academic and practical purposes to predict industry trends and the ability of pharmaceutical companies to create new products.

The paper confirms the fact that large-scale commercial success is necessary due to the development costs and high failure rate of many innovation areas.

A more *general question* that this research aims to answer is whether the innovative activity of companies will increase due to quality selection of top managers taking into account specifics of the industry?

This research fills a scientific gap regarding the study of the Issues of efficiency of R&D expenditure while increasing productivity.

Education in the company's core industry contributes to a better understanding of strategy and innovation. Nevertheless, there are studies that do not support a positive effect of management education and educational attainment in general on innovative activity explored by Barker & Mueller [1].

The late age of top management may have a negative impact on the indicators of innovation activity. This is justified by the fact that older top managers tend to make less risky decisions in anticipation of retirement, while younger top managers have a better understanding of innovation and are more receptive to change.

Work experience can also have a positive effect on innovation activity rates. The basic premise of this is that managers are imbued with the experience they gained during their earlier involvement in a particular field, so they perceive and interpret any situation based on their early experience. In this context, experience in managerial positions can enable top managers to make important managerial decisions necessary to overcome the uncertainty associated with innovation strategy.

Hypotheses under consideration:

H1a: The share of top managers with management and finance education has a positive effect on the innovative activity of pharmaceutical companies.

H1b: The share of top managers with management and finance education has a positive effect on the number of patents obtained by pharmaceutical companies.

H2a: The share of top managers with medical education has a positive effect on the innovative activity of pharmaceutical companies.

H2b: The share of top managers with medical education has a positive effect on the number of patents received by pharmaceutical companies.

H3a: Late age of top management negatively affects innovative activity of pharmaceutical companies.

H3b: Late age of top management is negatively related to the number of patents obtained by pharmaceutical companies.

H4a: Average managerial experience of top management positively influences innovative activity of pharmaceutical companies.

H4b: Average managerial experience of top management positively influences the number of patents received by pharmaceutical companies.

The structure of the study is an analytical review of research followed by identification of scientific gaps and search for practically proven claims in R&D and pharmacology. Further on the basis of the hypotheses put forward about the influence of human capital of top management on the innovation activity of pharmaceutical companies two models were tested. The models are panel regressions that were tested on patents and R&D. The models were tested using data from 100 world's top pharmaceutical companies from 2010 to 2022. The results and discussion of the research confirm that experience in managerial positions can enable top managers to make important management decisions necessary to overcome the uncertainty associated with innovation strategy.

2. Related literature

The literature on the topic can be split into three directions. The first direction is devoted to the specifics of the pharmaceutical industry. The present section of the research will help to determine the main mechanisms for protection of inventions in the pharmaceutical industry, as well as to identify the main directions of development and problems of the industry. The second section describes how the human capital of management teams affects innovation activity to define the variables of the study. The third section is a description of innovation activity that allows us to determine basic methodology.

2.1. Pharmaceutical industry features and procedure for patenting medicines

Nowadays, big pharmaceutical companies are increasingly facing the problem of falling R&D productivity. According to some studies, only one out of 10,000 discovered drug components is currently used as the active ingredient in a drug, that Miller & Lehoux [2] have written about in their studies. The detailed process of the drug component approval funnel in the drug manufacturing process is shown in Figure 1.

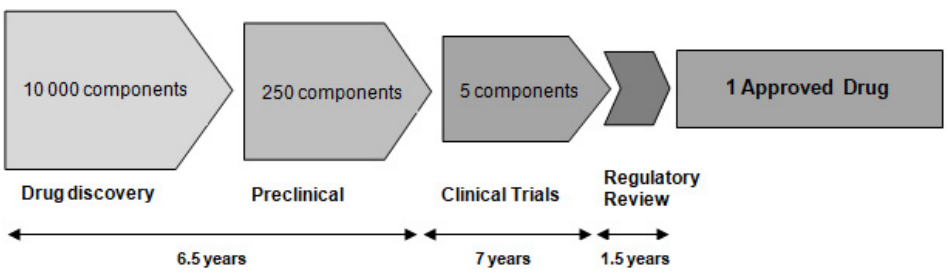

Figure 1. Open drug component funnel

With falling R&D productivity, increased regulatory scrutiny, and patent expiry undermining a significant portion of revenues, large pharmaceutical companies have realized the need to look outside their walls for innovation.

Jia & Tian [3] have stated the fact, that many companies have redirected R&D spending to external companies to license technology platforms or drug ideas. However, in some other knowledge-intensive industries such as biotechnology even the slightest change in the production environment has a large impact on product properties, which is a product defense against competition.

In this context, Ribeiro & Shapira [4] emphasize that in traditional pharmacology, intellectual rights are mainly protected through patents.

Kaitin [5] noted that the development of an active ingredient in pharmacology, takes typically 15 years. The process involves six major steps: (1) researching ideas and finding substance; (2) early preclinical studies, during which the safety of the planned clinical trial is confirmed; (3) early development stage, during which the technology for the development of the active pharmacologic element is established; (4) late phase development, during which methods for controlling the active pharmacologic element are established; (5) three phases of clinical trials, during which the mechanism of action of the drug, the efficacy of the drug and the evaluation of the risk-benefit ratio are tested; (6) a fourth phase of clinical trials, during which side effects are studied.

It should be noted that in the process of drug development, large pharmaceutical companies work closely with scientific institutes, biotech companies and smaller industry representatives, as well as contract research organizations. The latter conduct clinical trials that complete the product development process.

Since there is currently no single international system for granting patents, patents are granted by patent offices in specific territories. Thus, patent offices are divided into regional offices, which grant patents in several countries, and national offices, which grant patents in one country. This gives rise to the phenomenon of a "patent family" — a set of interrelated patent applications filed in several offices to protect the same or similar invention by a single inventor and linked by a common priority (or priorities).

Feldman & Notes [6] note that priority is the right to file applications for the same invention in other offices within 12 months of the filing of the first application and to specify the filing date of the first application. And the patenting of a medicinal product usually occurs at the early preclinical research stage.

The procedure of patenting an invention can be categorized into three steps: (1) Filing of the patent application; (2) Examination (includes first the documentary examination and then the longest part, the technological examination); (3) Obtaining a patent.

Most of the time in the patenting procedure is taken up by the technological examination. Its average duration in the industry is 24 months (Figure 2).

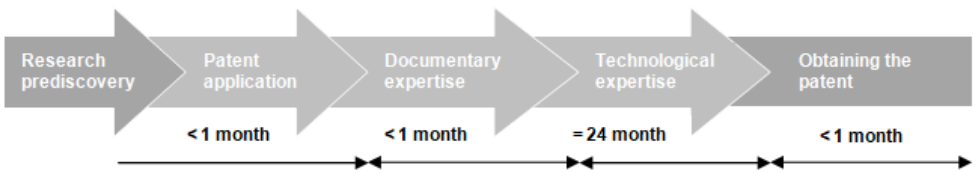

Figure 2. Patenting as part of the drug manufacturing process medicines

If we talk about the peculiarities of patenting in the pharmaceutical industry, it is important to note the problem of "evergreen patents" investigated by the Kim et al. [7]. With the help of such patents, pharmaceutical companies retain the exclusive right to produce products. For example, if a company has invented an active ingredient and registered a patent on it, then when the patent expires, the company can file a new patent application with a small modernization of the drug that will not significantly affect its therapeutic properties.

Thus, it is worth emphasizing the fact that relatively few studies are devoted to the impact of human capital characteristics on innovation activity, expressed in the ability to produce new medical products and technologies, which in turn can significantly improve the quality of life of patients by alleviating symptoms of diseases or preventing their development. It is important to note that in the drug development process, large pharmaceutical companies work closely with academic institutions, biotech companies and smaller industry players, as well as contract research organizations. Innovation allows pharmaceutical companies to remain competitive in the market, attract investment and attract talent. Moreover, research on innovation in the pharmaceutical industry has broad positive implications that contribute to the improvement of human health and the development of society as a whole.

The pharmaceutical industry is highly dependent on innovation, where patents are the main mechanism for protecting inventions in the pharmaceutical industry. The patent system in pharmaceutical is characterized by a high proportion of "evergreen patents", which are major improvements of existing inventions.

2.2. Empirical studies of human capital

According to Mahroum [8] human capital is an intangible asset that is not recognized on a company's balance sheet. It can be categorized as the economic value of employees' experience and skills. Human capital reflects employees' ability to generate knowledge, their individual values and attitudes, experience, and ability to bring innovation to established processes. Although human capital plays an important role in innovation, its complexity and subjectivity may make it less attractive for research compared to other areas of innovation, such as technology or production processes. The impact of investment in human capital can only be seen in the long term, making it difficult to conduct research on short time horizons. Therefore, key human capital indicators such as intellectual ability, creativity and motivation are an integral part of the research question in the pharmacology industry.

Human capital plays a major role in many fundamental works in the fields of management and organization theory. The first works devoted to the study of human capital appeared in the middle of the XX century, directly in the period of active study of management sciences, they investigate the characteristics of the top management team of the organization, which determine the cognitive structure of top management and thus affect organizational outcomes studied by Bandaranaike [9].

Studies of Binkley et al. [10] and Collet et al. [11] state that employee age, work experience revealed in the study of Karnouskos [12], and top management education revealed in the study of Rismawati et al. [13] influence firm performance, particularly innovation performance.

However, over the last decade, these results have not always been unambiguous, and a number of studies have found contradictory results for different companies and industries. For example, most studies confirm the division of human capital into the following types: basic (biophysical capital, professional education, length of

service and work experience, professional competencies, reputational and social capital) and specific (belonging to a team and loyalty to the company). The following division of forms of human capital is also common: knowledge capital, social capital and emotional capital were investigated by Li et al. [14].

Studies of Foucart & Li [15] suggest that firms' investment in R&D and their innovative products have a positive impact on the long-term financial health of the firm. In the pharmaceutical industry, characterized by a high R&D intensity, innovation has a large impact on firm performance as confirmed by research of Asaba & Wada [16].

All the employee characteristics studied can be broadly categorized into three categories:

1. Demographic characteristics such as gender, age, and education by Sena et al. [17]. Ahn et al. [18] and Crossland et al. [19] in addition to organization theory have also investigated the influence of top management characteristics at the interface of corporate finance and pharmacology, but they used average characteristics.
2. Career experience such as tenure revealed in the study of Omerzel & Jurdana [20], management experience revealed in the study of Custodio et al. [21] and industry expertise of top management revealed in the study of Nadkarni et al. [22].
3. Behavioral characteristics, such as risk appetite, intellectual and creative ability, leadership skills, and propensity to implement new ideas that have been explored in their work by Prugsamatz [23].

2.3. Innovative activity and an overview of approaches to its research

Innovations are new ideas, products, services, or processes that change the way people live and make the world a more advanced place. Innovations can be either radical or incremental, but in either case they represent significant changes to existing methods and approaches. Innovation can have a significant impact on innovation activity. New technologies and processes can stimulate innovation activity because they facilitate the development of new products and services.

In addition, innovation can lead to increased competition, which can encourage firms to create new products and services. However, innovation can also cause some challenges. Some companies may find it difficult to adapt to new technologies and processes, which may lead to a decrease in innovation. In addition, innovation may increase research and development costs, which may not be acceptable to some companies.

In general, innovation is an important factor for stimulating innovation activity. Companies that can successfully adapt to new technologies and processes can gain an advantage in the market and increase their competitiveness.

Luo et al. [24] disclosed different types of innovations, some of the main ones are technological and managerial innovations, those that are directly related to the productivity of processes and are strongly related to the core business of the company. Managerial innovations are innovations that are related to the management and control of the company, administrative processes and human resources. Product and process innovations, which involve the development of new products or services required to meet market needs, and represent new elements, equipment and methods in the company's production process required to create a product or service. Radical and incremental innovations, which are platforms for change in the operations of a single company or an entire industry. These include new technological and business skills, new ways of solving problems.

According to different studies, there are many approaches to investigate the in-

novation capability of a company. For example, Chao & Huang [25], while studying the effect of share repurchase on innovation activity, used the most straightforward way to determine innovation activity. They used a dummy variable that showed whether or not the company invested in R&D in a given period. A probit model was used to estimate such a model.

Innovation intensity can also be calculated by Herrmann et al. [26] using R&D to revenue ratio to investigate the effect of corporate governance on innovation intensity. The same method was used by Lewellyn et al. [27].

Shahzad et al. [28] used a similar model, but as the dependent variable analyzed the R&D to assets. Also, the variable of R&D to assets ratio has been used in the literature to find the intensity of innovation. It has been found in this way by Shaikh & Peters [29].

Studying the effect of ownership structure on innovation by Garcia-Garcia et al. [30] used the ratio of intangible assets to total assets. This method is convenient because very often there are problems in finding R&D expenditures of companies and Intangible assets can usually always be found. Thus, it is possible to avoid a large number of omissions of the dependent variable in the econometric model.

The above-mentioned papers have used variables that can be used to measure companies' efforts to innovate, i. e. innovation intensity. The variables by which the production or efficiency of innovation activity can be measured are considered by Qing et al. [31]. One of the most basic indicators of innovation production is the number of patents filed, for example, this indicator was used by Ramdani et al. [32].

Forti et al. [33] used the number of patents approved. Ma [34] used the number of patent citations and the average number of citations per patent to measure innovation production. These indicators allow us to study the effectiveness of innovation activity, that is, they show how much other scientists and researchers are interested in the company's scientific developments. The same method was used by Chkir et al. [35].

The results of the analysis of the literature show that relatively few works are devoted to the study of the impact of human capital on the innovation activity of companies' innovation activity of companies. In some of these studies, education in the spheres of management and finance is considered as a catalyst for the economic growth of the company, as confirmed by Chemmanur et al. [36].

Lee et al. [37] note that each of the listed indicators has its own limitations. For example, patents protect inventions rather than innovations, respectively, not all innovations are patented.

Camisón-Zornoza et al. [38] approve that the propensity to patent will differ depending on the strategy and industry of the firm. And such an indicator as R&D intensity measures innovation activity indirectly, as it gives an idea only about the contribution to innovation development and not about the innovativeness of the company.

Barrena-Martínez et al. [39] believe, that it is difficult for small companies to record formal R&D expenditures, as such expenditures may be classified as other expenses.

Despite numerous studies, it remains unclear whether existing methods for measuring innovation are applicable to real companies. Cruz-Cázaresa et al. [40] argue that the methods used in the literature seem too theoretical and not directly applicable to businesses.

3. Data and Method

To conduct the study, a list of the 100 largest pharmaceutical companies in the world by capitalization for 2023 was generated using Bloomberg's information database. The sample includes only the larg-

est companies because, as a rule, they are the most complete and reliable in reporting financial and non-financial information.

Espacenet Patent Database, a database of the European Patent Office, and Orbis Patent Database were used to collect patent data.

It is also worth noting that the study did not take into account the absolute number of patents, but the number of patents first obtained within the same patent family. Since patents for the same invention may be valid in different countries, the assessment of innovation activity simply through the absolute number of patents does not accurately reflect innovation activity.

The sample of 100 firms is unbalanced, due to the fact that most firms only listed after 2010, and also taking into account the events of the global crises in 2008 and 2020. The sample represents 1118 observations.

The study uses two measures of innovation activity: the natural logarithm of R&D intensity (LNR&D) in the first model, which characterizes innovation input, and the natural logarithm of the number of patents obtained by a company with a lag of two years (LNP) in the second model, which characterizes innovation output. The choice of the length of the time lag of the LNP indicator is justified by the duration of the patenting procedure described in detail in Figure 2. Based on the above, it follows that the article evaluates two indicators: innovation input and innovation output.

The explanatory variables used in the study represent the characteristics of top management human capital: average age of top management (AGE), average experience of top management (in years) in executive-level positions (EXP), share of top managers with education in management and finance (FINEDU), share of top managers with medical education (MEDEDU).

Control variables were also selected to reflect important factors that may have influenced the innovation activity of pharmaceutical companies. Company size, represented as the natural logarithm of the number of company employees (LNEMP), can have both positive and negative effects on innovation activity. This is because on the one hand, large firms may have more resources to develop sustainable innovation programs, while on the other hand large firm size and the market power it generates may provide less incentive for managers to invest in innovation.

Past financial performance can also have a large impact on innovation activity. The paper uses Return on Assets with a lag of one year (ROA) and the natural logarithm of net income (LNNI) as variables reflecting past period financial performance.

It is known that a high level of debt burden of a company reduces the motivation of management to invest in long-term research and development for the sake of increasing the current cash flow for debt service. The debt-to-assets ratio (LEV) is an indicator reflecting the level of debt load.

Based on the collected panel data, the following trends in the human capital characteristics of top management are clearly visible:

1) The age of top managers shows an increasing trend: from 45 years in 2010 to 53.2 years in 2022, with an average of 53 years.

2) The share of top managers with financial and medical education is almost unchanged — 50 %.

3) The share of top managers with medical education is increasing from 0.5 in 2010 to 0.6 in 2022.

4) The average work experience at top management positions ranges from 7.5 to 30 years, with an average of 12 years (Table 1).

Before building regression models, data were analyzed for association between regressors to detect multicollinearity (Table 2 and Table 3).

Table 1. **Descriptive statistics of variables**

Variable	Obs	Mean	Std. Dev.	Min	Max
LNR&D	1 118	0.97	0.389	0	0.984
LNP	1 118	1.856	0.69	0	4.885
AGE	1 118	53.381	2.141	45.5	60.5
MEDEDU	1 118	0.465	0.242	0.1	1
FINEDU	1 118	0.510	0.312	0	0.8
EXP	1 118	12.349	2.752	7.5	30.3
LNEMP	1 118	1.27	0.788	2.188	3.933
LNNI	1 118	4.189	0.631	0.911	5.333
ROA	1 118	0.207	0.08	–0.081	0.585
LEV	1 118	0.251	0.187	0	2.987

Table 2. **Correlation matrix for regression model (1)**

Variables	LNR&D	AGE	MEDEDU	FINEDE	EXP	LNEMP	LNNI	ROA	LEV
LNR&D	1.000								
AGE	0.067	1.000							
MEDEDU	0.137	–0.152	1.000						
FINEDU	0.164	0.189	–0.495	1.000					
EXP	0.120	0.289	0.218	0.162	1.000				
LNEMP	–0.065	–0.040	–0.318	–0.160	–0.280	1.000			
LNNI	0.046	0.126	–0.405	0.006	–0.195	0.242	1.000		
ROA	0.124	0.113	–0.112	0.109	0.032	–0.212	0.169	1.000	
LEV	–0.159	–0.031	0.021	–0.071	–0.095	0.141	0.190	–0.088	1.000

Table 3. **Correlation matrix for regression model (2)**

Variables	LNP	AGE	MEDEDU	FINEDE	EXP	LNEMP	LNNI	ROA	LEV
LNP	1.000								
AGE	0.065	1.000							
MEDEDU	–0.273	0.141	1.000						
FINEDU	–0.179	0.189	–0.505	1.000					
EXP	–0.387	0.344	0.218	0.192	1.000				
LNEMP	0.530	–0.040	–0.318	–0.170	–0.280	1.000			

End of table 3

Variables	LNP	AGE	MEDEDU	FINEDE	EXP	LNEMP	LNNI	ROA	LEV
LNNI	0.435	0.126	–0.405	0.006	–0.195	0.694	1.000		
ROA	–0.112	0.139	–0.012	0.101	0.035	–0.212	0.170	1.000	
LEV	–0.316	–0.003	0.005	–0.007	–0.095	–0.141	0.144	0.078	1.000

There is no significant correlation between the variables (correlation does not exceed 60 %). Therefore, there is no correlation above the threshold value of 60 %, which allows us to reject the problem of multicollinearity between the variables. The results most adequately describe the fixed effects models, which allows us to make the assumption that there is no heteroskedasticity.

4. Econometric Model

The influence of top management characteristics on the innovation activity of pharmaceutical companies is investigated using econometric analysis of panel data in two models (1) и (2).

$$\begin{aligned} LNR\,\&\,D_{i,t} = \beta_0 + \beta_1 AGE_{i,t} + \\ \beta_2 FINEDU_{i,t} + \beta_3 MEDEDU_{i,t} + \\ \beta_4 EXP_{i,t} + \beta_5 LNEMP_{i,t} + \\ \beta_6 LNNI_{i,t} + \beta_7 ROA_{i,t} + \beta_8 LEV_{i,t} + \varepsilon_{i,t}, \end{aligned} \quad (1)$$

where $LNR\,\&\,D_{i,t} = LN\left(R\,\&\,D/Revenue\right)$, $AGE_{i,t}$ — average age of top managers, $FINEDU_{i,t}$ — Share of top managers with Management and Finance education, $MEDEDU_{i,t}$ — Share of top managers with Medical education, $EXP_{i,t}$ — average work experience of top managers, $LNEMP_{i,t} = LN(Staff\ Number)$, $LNNI_{i,t} = LN(Net\ Income)$ with a time lag of 1 year, $ROA_{i,t} = Net\ Income / Total\ Assets$, $LEV_{i,t} = Total\ Debt / Total\ Assets$.

$$\begin{aligned} LNP_i^{t+2} = \beta_0 + \beta_1 AGE_{i,t} + \\ +\beta_2 FINEDU_{i,t} + \beta_3 MEDEDU_{i,t} + \\ \beta_4 EXP_{i,t} + \beta_5 LNEMP_{i,t} + \\ +\beta_6 LNNI_{i,t} + \beta_7 ROA_{i,t} + \\ +\beta_8 LEV_{i,t} + \varepsilon_{i,t}, \end{aligned} \quad (2)$$

where $LNP_i^{t+2} = LN\left(Patent\ Number\right)$ with a time lag of 2 years, $AGE_{i,t}$ — average age of top managers, $FINEDU_{i,t}$ — Share of top managers with Management and Finance education, $MEDEDU_{i,t}$ — Share of top managers with Medical education, $EXP_{i,t}$ — average work experience of top managers, $LNEMP_{i,t} = LN(Staff\ Number)$, $LNNI_{i,t} = LN(Net\ Income)$ with a time lag of 1 year, $ROA_{i,t} = Net\ Income / Total\ Assets$, $LEV_{i,t} = Total\ Debt / Total\ Assets$.

For each of the models, a series of tests were conducted to determine, which of the panel data estimation methods — pass-through, regression with regression with fixed individual effects and regression with random individual effects — better describes the data. The results of the tests suggest that both regressions most adequately describe the fixed effects model. The models were also tested for autocorrelation and heteroscedasticity using the Durbin-Watson test and White's test, respectively, where the test results showed that there is no autocorrelation and heteroscedasticity in both models.

5. Results

According to the results of model (1) presented in Table 4, the share of top managers with medical education has an insignificant effect on R&D intensity in the largest pharmaceutical companies, where the mature age of top management representative is negatively and significantly related to R&D intensity ($t = –0.00985$, $p < 0.01$). The share of top managers with education in finance is not significant. Average experience in managerial positions among top managers is positively and significant-

ly related to R&D intensity (t = 0.2547, p < 0.01).

Pharmaceutical company size, represented as number of employees, is negatively related to R&D intensity, which confirms some previous studies for high-tech sectors. Other control variables representing financial performance have no significant coefficients in model (1).

Therefore, *Hypothesis 1a* indicating that the proportion of top managers with management and finance education is positively related to R&D intensity of pharmaceutical companies — cannot be confirmed or accepted, due to the ambiguity of the findings, but *Hypothesis 2a* is not rejected and the fact that medical education has a positive effect on innovation is confirmed.

Hypothesis 3a and *Hypothesis 4a* are also accepted. This is due to the fact that the mature age of top management members is negatively related to contribution to innovation (R&D intensity), while greater experience allows them to make informed decisions while holding senior positions. Older employees in anticipation of retirement life tend to make less risky decisions, while younger top managers have a better understanding of innovation and are more receptive to change. The result obtained is in line with the research result for other industries for R&D intensity that Barker V. and Mueller G. [1] explored in their paper «CEO Characteristics and Firm R&D Spending».

The results of model (2) disprove the *Hypothesis 2b* hypothesis about the positive relationship between the share of top managers with medical education and the number of patents obtained by the company. The results of model (2) showed that this relationship is negative and significant (t = –0.6549, p < 0.01).

The obtained result refutes the results of foreign authors by Lee et al [37], who claimed that in innovative industries the share of top managers with industry-specific education positively affects the number of patents obtained. It is worth noting that *Hypothesis 4b* is also confirmed. Management teams with a higher share of employee representatives with more than 10 years of experience have better quality of top management, which will allow the company's employees to fulfill their tasks more efficiently. The rest of the indicators are not significant, so it is impossible to draw unambiguous conclusions about the acceptance or rejection of the hypotheses.

Table 4. **Influence of top managers' characteristics on innovative activity**

	Model (1)	Model (2)		Model (1)	Model (2)
AGE	-0.00985**	0.00364	LNNI	0.0103	0.4162*
	(0.00452)	(0.0217)		(0.0379)	(0.0836)
MEDEDU	0.3874*	-0.6549**	ROA	-0.462	-1.450**
	(0.0860)	(0.1291)		(0.162)	(0.383)
FINEDU	0.2135	-0.070	LEV	0.0247	0.0245
	(0.1748)	(0.023)		(0.0524)	(0.0504)
EXP	0.2547**	0.4205*	Const	0.536*	1.991*
	(0.4335)	(0.1454)		(0.272)	(0.522)
LNEMP	-0.197*	0.425**	N	1 118	1 118
	(0.289)	(0.105)	R^2	0.471	0.394

This trend could be due to the fact that the number of patents granted in the second half of the time period under study decreased, which affected the results of the analysis. Moreover, there is a tendency for the industry to decrease R&D productivity, which could have also had a negative impact on the number of discovered active ingredients and, consequently, on the number of patents granted.

The results of model (2) could be affected by "evergreen patents", the share of which in the total number of patents of a pharmaceutical company can reach large values but varies from company to company.

Based on the results of the models, it is worth noting that if the concentration of hiring top managers with managerial skills with more than 20 years of experience increases by 1 %, the innovation activity of the company increases by 0.25 % for input innovation and 0.42 % for output innovation. Since innovation is aimed at cost optimization and automation of internal processes, special attention is paid to employees with specialized medical education, where when the share of top managers with medical education increases by 1 %, innovation activity increases by 0.39 % for input innovation, but decreases by 0.65 % for output input innovation.

This is explained by the fact that, despite the relatively small share of top managers, investors are interested in overcoming corporate problems in order to normalize and maximize exclusively the economic performance of the company and exclusively in the long term, without taking into account pharmacological aspects. This is also confirmed by the number of company employee's indicator, where in the case of innovation expansion for top managers with medical education, if the share of all employees increases by 1 %, innovation activity increases by 0.43 %.

The share of top managers with education in management and finance does not have a proper significance on innovation activity, therefore the results are ambiguous and cannot be compared with the share of top managers with medical education. Thus, the intensity of innovation increases due to the involvement of top managers with a certain business interest in their portfolio companies, where the costs of monitoring in pharmacology significantly exceed the corresponding costs of independent other companies from other industries.

6. Discussion

The information presented in the article will allow investors to choose the right strategic directions when planning external investments. Company owners can also use the data to develop innovation strategies and analysts to forecast trends in the industry in order to develop new products.

The article suggests that in the pharmaceutical industry, innovation activity, which is the most important factor for survival in a competitive environment, also depends on the characteristics of human capital of top management, namely age, education and work experience.

The empirical analysis conducted in the study showed that some characteristics of human capital of top management can have a significant impact on the indicators of innovation activity of companies. We found a positive relationship between the average work experience of top managers and R&D intensity, a negative relationship between the late age of top managers and R&D intensity, and a positive relationship between the share of top managers with medical education and R&D intensity. The hypothesis, which states that the share of top managers with medical education has a positive effect on the innovative activity and number of patents received by pharmaceutical companies is not rejected. The result obtained is similar to earlier empirical studies for other industries by Barker & Mueller [1].

The authors in their research note that the characteristics of human capital can positively influence the innovative development of the company. Empirical evidence supported this notion and showed that age disclosed in the paper of Vania et al. [17], work experience disclosed in the paper of Doris & Dora [20] and education of top management disclosed in the paper of Garg [13] affect firm performance, particularly innovation performance.

A negative relationship was also found between the share of top managers with medical education and the number of patents initiated during the period of top managers' work. At the same time, the number of patents obtained reflects the innovation output of the company.

The result obtained in this study refutes the results of foreign researchers that in high-tech industries the industry-specific education of top managers contributes to the increase in the number of patents by Lee et al [37]. This is explained by the specificity of the patent system in the pharmaceutical industry. In this regard, the measurement of the innovative output of pharmaceutical companies in further studies can be carried out with the help of other absolute indicators of innovation, e. g. by using other absolute indicators of innovation, for example, the number of new drugs.

However, the hypothesis which states that average managerial experience of top management positively influences innovative activity and the number of patents of pharmaceutical companies is not rejected.

The results of the paper are also supported by the work of Shaikh & Peters [29], where based on the results obtained, the researchers agree that the high level of debt load of a company, expressed as an indicator reflecting the level of debt load, reduces the motivation of management to invest in long-term R&D for the sake of increasing the current cash flow for debt service, which is also affected by the strong degree of government regulation and the falling number of new drugs per R&D unit.

The study has some weaknesses. Firstly, not all characteristics of top management's human capital are considered in the study, as the research was limited to measurements using secondary information. Perhaps, a more extensive set of characteristics will allow us to analyze more deeply the mechanism of top management human capital influence on the innovation activity of pharmaceutical companies. Secondly, the study does not take into account such aspects as the stage of the company's life cycle, country affiliation and diversification of production, which can also have a significant impact on the innovation activity indicators.

7. Conclusion

Human capital is the knowledge, skills, experience, and education of people who work in a company. It is a key factor influencing innovation in a company. Senior management regulates most of the company's activities. In most cases, when considering the activities of management, external factors that influence the decision-making process are taken into account.

However, endogenous factors are considered much less frequently, although they are of considerable importance in decision-making processes. While exogenous factors are more objective and visible for unbiased evaluation, endogenous factors are less visible and require a more comprehensive approach for evaluation. In this regard, the relationship between the human capital of top management and the characteristics of these very companies has been confirmed.

The growth of the industry is slowing down as investment in research and development becomes less efficient, external controls are increasing, and companies are increasingly having to collaborate with each other on innovation, creating more complex management and control struc-

tures. The lack of a consolidated patent system forces companies to spend a lot of time filing patents with several offices to protect themselves from competitors. Imperfections in patent law also make it possible to re-register patents on a product after minor modifications, which negates the need for new products.

However, the study confirms the fact that the influence of the leadership structure characterizes a certain aspect of the company's activity, where there are also interactions within this structure. Decisions in the company are not made unilaterally, but one of the management representatives has significantly more authority than other managers, which ultimately makes it necessary to take into account separately the influence of the CEO on the decisions made by the management.

The findings of the paper give important strategic importance to R&D investments in order to maintain leadership and competitive advantage for companies in the pharmaceutical industry. The results close many research gaps whose studies are limited to using only one variety of human capital characteristics. The results of the study may also be useful in lectures, seminars, or other topical forums.

The present study complements the previous works by specifying the characteristics of human capital of top management, which influence the innovation activity indicators of the largest companies, as applied to the pharmacological industry. This is relevant due to the fact that, as the literature review has shown, most of the previous works focused either on a set of high-tech industries or on the IT sector.

In addition, the study investigates the impact of average experience in managerial positions on innovation performance, which has previously been investigated only for CEOs and not for top management in general. The practical significance of the research is that the proposed model, which will help predict the innovation strategy of pharmaceutical companies, can be used by investors when planning external investments, by owners when developing an innovation strategy, by analysts to forecast trends in the industry, and the ability of pharmaceutical companies to create new products.

References

1. Barker, V.L., Mueller, G.C. (2002). CEO Characteristics and Firm R&D Spending. *Management Science,* Vol. 48, No. 6, 782–801. http://dx.doi.org/10.1287/mnsc.48.6.782.187

2. Miller, F.A., Lehoux, P. (2020). The innovation impacts of public procurement offices: The case of healthcare procurement. *Research Policy,* Vol. 49, Issue 7, 104075. https://doi.org/10.1016/j.respol.2020.104075

3. Jia, N., Tian, X. (2018). Accessibility and materialization of firm innovation. *Journal of Corporate Finance,* Vol. 48, 515–541. https://doi.org/10.1016/j.jcorpfin.2017.12.002

4. Ribeiro, B., Shapira, P. (2018). Private and public values of innovation: A patent analysis of synthetic biology. *Research Policy,* Vol. 49, Issue 1, 103875. https://doi.org/10.1016/j.respol.2019.103875

5. Kaitin, K.I. (2010). Deconstructing the Drug Development Process: The New Face of Innovation. *Clinical Pharmacology & Therapeutics,* Vol. 87, Issue 3, 356–361. https://doi.org/10.1038/clpt.2009.293

6. Feldman, R., Notes, A. (2018). May your drug price be evergreen. *Journal of Law and the Biosciences,* Vol. 5, Issue 3, 590–647. https://doi.org/10.1093/jlb/lsy022

7. Kim, I., Pantzalis, C., Zhang, Z. (2021). Multinationality and the value of green innovation. *Journal of Corporate Finance,* Vol. 69, 101996. https://doi.org/10.1016/j.jcorpfin.2021.101996

8. Mahroum, S. (2002). Europe and the Immigration of Highly Skilled Labour. *International Migration,* Vol. 39, Issue 5, 27–43. https://doi.org/10.1111/1468-2435.00170

9. Bandaranaike, S. (2018). From Research Skill Development to Work Skill Development. *Journal of University Teaching & Learning Practice,* Vol. 15, Issue 4. 7. https://doi.org/10.53761/1.15.4.7

10. Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., Rumble, M. (2012). Defining Twenty-First Century Skills. *In: Assessment and Teaching of 21st Century Skills.* Edited by P. Griffin, B. McGaw, E. Care. Springer, 17–66. http://dx.doi.org/10.1007/978-94-007-2324-5_2

11. Collet C., Hine, D., du Plessis, K. (2015). Employability skills: perspectives from a knowledge-intensive industry. *Education and Training,* Vol. 57, Issue 5, 532–559. https://doi.org/10.1108/ET-07-2014-0076

12. Karnouskos, S. (2017). Massive open online courses (MOOCs) as an enabler for competent employees and innovation in industry. *Computers in Industry,* Vol. 91, 1–10. https://doi.org/10.1016/j.compind.2017.05.001

13. Sitepu, R.Br., Eliyana, A., Raza, A., Rosalina, M. (2020). The Readiness of Educational Competency in Higher Education in Connecting the Era of Industrial Revolution 4.0. *SHS Web of Conferences,* Vol. 76, Issue 2, 01045. https://doi.org/10.1051/shsconf/20207601045

14. Li, X., Nosheen, S., Ul Haq, N., Gao, X. (2021). Value creation during fourth industrial revolution: Use of intellectual capital by most innovative companies of the world. *Technological Forecasting and Social Change,* Vol. 163, 120479. https://doi.org/10.1016/j.techfore.2020.120479

15. Foucart, R., Li, Q.C. (2021). The role of technology standards in product innovation: Theory and evidence from UK manufacturing firms. *Research Policy,* Vol. 50, Issue 2, 104157. https://doi.org/10.1016/j.respol.2020.104157

16. 16. Asaba, S., Wada, T. (2019). The Contact-Hitting R&D Strategy of Family Firms in the Japanese Pharmaceutical Industry. *Family Business Review,* Vol. 32, Issue 3, 277–295. https://doi.org/10.1177/0894486519852449

17. Sena, V., Duygun, M., Lubrano, G., Marra, M., Shaban, M. (2018). Board independence, corruption and innovation. Some evidence on UK subsidiaries. *Journal of Corporate Finance,* Vol. 50, 22–43. https://doi.org/10.1016/j.jcorpfin.2017.12.028

18. Ahn, J.M., Mortara, L., Tim, M. (2013). Linkages between CEO Characteristics and Open Innovation Adoption in Innovative Manufacturing SMEs. *SSRN,* 35 p. http://dx.doi.org/10.2139/ssrn.2328644

19. Crossland, C., Zyung, J., Hiller, N.J., Hambrick, D.C. (2014). Ceo career variety: Effects on firm-level strategic and social novelty. *Academy of Management Journal,* Vol. 57, No. 3, 652–674. https://doi.org/10.5465/amj.2012.0469

20. Omerzel, D.G., Jurdana, D.S. (2016). The influence of intellectual capital on innovativeness and growth in tourism SMEs: empirical evidence from Slovenia and Croatia. *Economic Research-Ekonomska Istraživanja,* Vol. 29, Issue 1, 1075–1090. http://dx.doi.org/10.1080/1331677X.2016.1211946

21. Custódio, C., Ferreira, M.A., Matos, P. (2017). Do General Managerial Skills Spur Innovation? *Management Science,* Vol. 65, No. 2, 459–476. https://doi.org/10.1287/mnsc.2017.2828

22. Nadkarni, S., Herrmann, P. (2010). CEO personality, strategic flexibility, and firm performance: The case of the Indian business process outsourcing industry. *Academy of Management Journal,* Vol. 53, No. 5, 1050–1073. https://doi.org/10.5465/amj.2010.54533196

23. Prugsamatz, N.C. (2021). CEO dominance and firm innovation effort. *Managerial Finance,* Vol. 47, Issue 7, 998-1015. https://doi.org/10.1108/MF-05-2020-0235

24. Luo, J.-H., Li, X., Wang, L.C., Liu, Y. (2021). Owner type, pyramidal structure and R&D Investment in China's family firms. *Asia Pacific Journal of Management,* Vol. 38, Issue 3, 1085–1111. https://doi.org/10.1007/s10490-019-09702-z

25. Chao, Ch.-H., Huang, Ch.-J. (2022). Firm performance following actual share repurchases: Effects of investment crowding out and financial flexibility. *Pacific-Basin Finance Journal,* Vol. 73, 101738. https://doi.org/10.1016/j.pacfin.2022.101738

26. Herrmann, P., Kaufmann, J., van Auken, H. (2010). The role of corporate governance in R&D intensity of US-based international firms. *International Journal of Commerce and Management,* Vol. 20, Issue 2, 91–108. https://doi.org/10.1108/10569211011057236

27. Lewellyn, K.B., Bao, R.S. (2021). R&D investment around the world: Effects of ownership and performance-based cultural contexts. *Thunderbird International Business Review,* Vol. 63, Issue 2, 217–233. https://doi.org/10.1002/tie.22187

28. Shahzad, F., Ahmad, M., Fareed, Z., Wang, Z. (2022). Innovation decisions through firm life cycle: A new evidence from emerging markets. *International Review of Economics & Finance,* Vol. 78, 51–67. https://doi.org/10.1016/j.iref.2021.11.009

29. Shaikh, I.A., Peters, L. (2018). The value of board monitoring in promoting R&D: a test of agency-theory in the US context. *Journal of Management & Governance,* Vol. 22, Issue 2, 339–363. https://doi.org/10.1007/s10997-017-9390-8

30. García-García, L Alonso-Buenaposada, M.G., Romero-Merino, M.E., Santamaria-Mariscal, M. (2020). Ownership structure and R&D investment: the role of identity and contestability in Spanish listed firms. *Academia Revista Latinoamericana de Administración,* Vol. 33, Issue 3–4, 405–426. https://doi.org/10.1108/ARLA-01-2019-0013

31. Qing, L., Wang, M., Xiangli, L. (2021). Do government subsidies promote new-energy firms' innovation? Evidence from dynamic and threshold models. *Journal of Cleaner Production,* Vol. 286, 124992. https://doi.org/10.1016/j.jclepro.2020.124992

32. Ramdani, B., Guermat, C., Mellahi, K. (2021). The effect of downsizing on innovation outputs: The role of resource slack and constraints. *Australian Journal of Management,* Vol. 46, Issue 2, 346–365. https://doi.org/10.1177/03128962209706

33. Forti, E., Morricone, S., Munari, F. (2021). Litigation risks and firms innovation dynamics after the IPO. *Journal of Industrial and Business Economics,* Vol. 48, Issue 2, 291–313. https://doi.org/10.1007/s40812-020-00161-y

34. Ma, S. (2020). The life cycle of corporate venture capital. *The Review of Financial Studies,* Vol. 33, Issue 1, 358–394. https://doi.org/10.1093/rfs/hhz042

35. Chkir, I., Haj Hassan, B.E., Rjiba, H., Saadi, S. (2021). Does corporate social responsibility influence corporate innovation? International evidence. *Emerging Markets Review,* Vol. 46, 100746. https://doi.org/10.1016/j.ememar.2020.100746

36. Chemmanur, Th.J., Kong, L., Krishnan, K., Qianqian, Y. (2015). Top Management Human Capital, Inventor Mobility, and Corporate Innovation. *Journal of Financial and Quantitative Analysis (JFQA),* 1–88. http://dx.doi.org/10.2139/ssrn.2654416

37. Lee, C., Park, G., Marhold, K., Kang, J. (2017). Top management team's innovation-related characteristics and the firm's explorative R&D: an analysis based on patent data. *Scientometrics,* Vol. 111, Issue 2, 639–663. https://doi.org/10.1007/s11192-017-2322-1

38. Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M., Boronat-Navarro M. (2004). A Meta-analysis of Innovation and Organizational Size. *Organization Studies,* Vol. 25, Issue 3, 331–361. https://doi.org/10.1177/0170840604040039

39. 39. Barrena-Martínez, J., Cricelli, L., Ferrándiz, E., Greco, M., Grimaldi, M. (2020). Joint forces: Towards an integration of intellectual capital theory and the open innovation paradigm. *Journal of Business Research,* Vol. 112, 261–270. https://doi.org/10.1016/j.jbusres.2019.10.029

40. Cruz-Cázares, C., Bayona-Sáez, C., García-Marco, T. (2013). You can't manage right what you can't measure well: Technological innovation efficiency. *Research Policy,* Vol. 42, Issue 6–7, 1239–1250. https://doi.org/10.1016/j.respol.2013.03.012

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Влияние характеристик топ-менеджеров на инновационную активность ведущих мировых фармацевтических компаний

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Аннотация. Стратегия инновационного развития компании в большей степени определяется топ-менеджерами, где все изменения, происходящие в фармацевтической отрасли, требуют детального рассмотрения вопросов стимулирования инноваций. Таким образом, важно изучить, какие характеристики человеческого капитала топ-менеджеров влияют на инновационную активность фармацевтических компаний при создании новых продуктов. В статье выдвигается гипотеза о том, что успех портфеля лекарственных препаратов прямо или косвенно зависит от идей, возникающих в ходе масштабной коммерциализации и фундаментальных исследований, окупающих высокие затраты на разработку, на которые в свою очередь влияют личностные характеристики топ-менеджеров. Исследование представляет собой эконометрический анализ влияния элементов человеческого капитала, представленного характеристиками топ-менеджеров, на инновационную активность крупных фармацевтических компаний, где с помощью панельной регрессии были протестированы две модели влияния переменных на патенты и НИОКР. Статистические данные были протестированы на 100 ведущих мировых фармацевтических компаниях в период с 2010 по 2022 г. Полученные результаты позволили составить усредненный портрет топ-менеджера одной из крупнейших фармацевтических компаний. Анализ показал, что профессиональный опыт, возраст, а также профильное образование оказывают существенное влияние на инновационную активность. Исследование вносит вклад в литературу, поскольку позволяет спрогнозировать инновационную стратегию фармацевтических компаний на основе усредненного портрета топ-менеджера. Предлагаемая модель позволит снизить количество неудач инновационных направлений, оптимизировать сроки коммерциализации проектов по разработке новых лекарственных средств и может быть использована в других научных исследованиях.

Ключевые слова: инновационная активность; НИОКР; патенты; топ-менеджмент; человеческий капитал.

Список использованных источников

1. *Barker V. L., Mueller G. C.* CEO Characteristics and Firm R&D Spending // Management Science. 2002. Vol. 48, No. 6. Pp. 782–801. http://dx.doi.org/10.1287/mnsc.48.6.782.187

2. *Miller F. A., Lehoux P.* The innovation impacts of public procurement offices: The case of healthcare procurement // Research Policy. 2020. Vol. 49, Issue 7. 104075. https://doi.org/10.1016/j.respol.2020.104075

3. *Jia N., Tian X.* Accessibility and materialization of firm innovation // Journal of Corporate Finance. 2018. Vol. 48. Pp. 515–541. https://doi.org/10.1016/j.jcorpfin.2017.12.002

4. *Ribeiro B., Shapira P.* Private and public values of innovation: A patent analysis of synthetic biology // Research Policy. 2018. Vol. 49, Issue 1. 103875. https://doi.org/10.1016/j.respol.2019.103875

5. *Kaitin K. I.* Deconstructing the Drug Development Process: The New Face of Innovation // Clinical Pharmacology & Therapeutics. 2010. Vol. 87, Issue 3. Pp. 356–361. https://doi.org/10.1038/clpt.2009.293

6. *Feldman R., Notes A.* May your drug price be evergreen // Journal of Law and the Biosciences. 2018. Vol. 5, Issue 3. Pp. 590–647. https://doi.org/10.1093/jlb/lsy022

7. *Kim I., Pantzalis C., Zhang Z.* Multinationality and the value of green innovation // Journal of Corporate Finance. 2021. Vol. 69. 101996. https://doi.org/10.1016/j.jcorpfin.2021.101996

8. *Mahroum S.* Europe and the Immigration of Highly Skilled Labour // International Migration. 2002. Vol. 39, Issue 5. Pp. 27–43. https://doi.org/10.1111/1468-2435.00170

9. *Bandaranaike S.* From Research Skill Development to Work Skill Development // Journal of University Teaching & Learning Practice. 2018. Vol. 15, Issue 4. 7. https://doi.org/10.53761/1.15.4.7

10. *Binkley M., Erstad O., Herman J., Raizen S., Ripley M., Miller-Ricci M., Rumble M.* Defining Twenty-First Century Skills // Assessment and Teaching of 21st Century Skills / edited by P. Griffin, B. McGaw, E. Care. Springer, 2012. Pp. 17–66. http://dx.doi.org/10.1007/978-94-007-2324-5_2

11. *Collet C., Hine D., du Plessis K.* Employability skills: perspectives from a knowledge-intensive industry // Education and Training. 2015. Vol. 57, Issue 5. Pp. 532–559. https://doi.org/10.1108/ET-07-2014-0076

12. *Karnouskos S.* Massive open online courses (MOOCs) as an enabler for competent employees and innovation in industry // Computers in Industry. 2017. Vol. 91. Pp. 1–10. https://doi.org/10.1016/j.compind.2017.05.001

13. *Sitepu R.Br., Eliyana A., Raza A., Rosalina M.* The Readiness of Educational Competency in Higher Education in Connecting the Era of Industrial Revolution 4.0 // SHS Web of Conferences. 2020. Vol. 76, Issue 2. 01045. https://doi.org/10.1051/shsconf/20207601045

14. *Li X., Nosheen S., Ul Haq N., Gao X.* Value creation during fourth industrial revolution: Use of intellectual capital by most innovative companies of the world // Technological Forecasting and Social Change. 2021. Vol. 163. 120479. https://doi.org/10.1016/j.compind.2017.05.001

15. *Foucart R., Li Q. C.* The role of technology standards in product innovation: Theory and evidence from UK manufacturing firms // Research Policy. 2021. Vol. 50, Issue 2. 104157. https://doi.org/10.1016/j.respol.2020.104157

16. *Asaba S., Wada T.* The Contact-Hitting R&D Strategy of Family Firms in the Japanese Pharmaceutical Industry // Family Business Review. 2019. Vol. 32, Issue 3. Pp. 277–295. https://doi.org/10.1177/0894486519852449

17. *Sena V., Duygun M., Lubrano G., Marra M., Shaban M.* Board independence, corruption and innovation. Some evidence on UK subsidiaries // Journal of Corporate Finance. 2018. Vol. 50. Pp. 22–43. https://doi.org/10.1016/j.jcorpfin.2017.12.028

18. *Ahn J. M., Mortara L., Tim M.* Linkages between CEO Characteristics and Open Innovation Adoption in Innovative Manufacturing SMEs. SSRN, 2013. 35 p. http://dx.doi.org/10.2139/ssrn.2328644

19. *Crossland C., Zyung J., Hiller N. J., Hambrick D. C.* Ceo career variety: Effects on firm-level strategic and social novelty // Academy of Management Journal. 2014. Vol. 57, No. 3. Pp. 652–674. https://doi.org/10.5465/amj.2012.0469

20. *Omerzel D. G., Jurdana D. S.* The influence of intellectual capital on innovativeness and growth in tourism SMEs: empirical evidence from Slovenia and Croatia // Economic Research-Ekonomska Istraživanja. 2016. Vol. 29, Issue 1. Pp. 1075–1090. http://dx.doi.org/10.1080/1331677X.2016.1211946

21. *Custódio C., Ferreira M. A., Matos P.* Do General Managerial Skills Spur Innovation? // Management Science. 2017. Vol. 65, No. 2. Pp. 459–476. https://doi.org/10.1287/mnsc.2017.2828

22. *Nadkarni S., Herrmann P.* CEO personality, strategic flexibility, and firm performance: The case of the Indian business process outsourcing industry // Academy of Management Journal. 2010. Vol. 53, No. 5. Pp. 1050–1073. https://doi.org/10.5465/amj.2010.54533196

23. *Prugsamatz N. C.* CEO dominance and firm innovation effort // Managerial Finance. 2021. Vol. 47, Issue 7. Pp. 998-1015. https://doi.org/10.1108/MF-05-2020-0235

24. *Luo J.-H., Li X., Wang L. C., Liu Y.* Owner type, pyramidal structure and R&D Investment in China's family firms // Asia Pacific Journal of Management. 2021. Vol. 38, Issue 3. Pp. 1085–1111. https://doi.org/10.1007/s10490-019-09702-z

25. *Chao Ch.-H., Huang Ch.-J.* Firm performance following actual share repurchases: Effects of investment crowding out and financial flexibility // Pacific-Basin Finance Journal. 2022. Vol. 73. 101738. https://doi.org/10.1016/j.pacfin.2022.101738

26. *Herrmann P., Kaufmann J., van Auken H.* The role of corporate governance in R&D intensity of US-based international firms // International Journal of Commerce and Management. 2010. Vol. 20, Issue 2. Pp. 91–108. https://doi.org/10.1108/10569211011057236

27. *Lewellyn K. B., Bao R. S.* R&D investment around the world: Effects of ownership and performance-based cultural contexts // Thunderbird International Business Review. 2021. Vol. 63, Issue 2. Pp. 217–233. https://doi.org/10.1002/tie.22187

28. *Shahzad F., Ahmad M., Fareed Z., Wang Z.* Innovation decisions through firm life cycle: A new evidence from emerging markets // International Review of Economics & Finance. 2022. Vol. 78. Pp. 51–67. https://doi.org/10.1016/j.iref.2021.11.009

29. *Shaikh I. A., Peters L.* The value of board monitoring in promoting R&D: a test of agency-theory in the US context // Journal of Management & Governance. 2018. Vol. 22, Issue 2. Pp. 339–363. https://doi.org/10.1007/s10997-017-9390-8

30. *García-García L., Alonso-Buenaposada M. G., Romero-Merino M. E., Santamaria-Mariscal M.* Ownership structure and R&D investment: the role of identity and contestability in Spanish listed firms // Academia Revista Latinoamericana de Administración. 2020. Vol. 33, Issue 3–4. Pp. 405–426. https://doi.org/10.1108/ARLA-01-2019-0013

31. *Qing L., Wang M., Xiangli L.* Do government subsidies promote new-energy firms' innovation? Evidence from dynamic and threshold models // Journal of Cleaner Production. 2021. Vol. 286. 124992. https://doi.org/10.1016/j.jclepro.2020.124992

32. *Ramdani B., Guermat C., Mellahi K.* The effect of downsizing on innovation outputs: The role of resource slack and constraints // Australian Journal of Management. 2021. Vol. 46, Issue 2. Pp. 346–365. https://doi.org/10.1177/03128962209706

33. *Forti E., Morricone S., Munari F.* Litigation risks and firms innovation dynamics after the IPO // Journal of Industrial and Business Economics. 2021. Vol. 48, Issue 2. Pp. 291–313. https://doi.org/10.1007/s40812-020-00161-y

34. *Ma S.* The life cycle of corporate venture capital // The Review of Financial Studies. 2020. Vol. 33, Issue 1. Pp. 358–394. https://doi.org/10.1093/rfs/hhz042

35. *Chkir I., Haj Hassan B. E., Rjiba H., Saadi S.* Does corporate social responsibility influence corporate innovation? International evidence // Emerging Markets Review. 2021. Vol. 46. 100746. https://doi.org/10.1016/j.ememar.2020.100746

36. *Chemmanur Th.J., Kong L., Krishnan K., Qianqian Y.* Top Management Human Capital, Inventor Mobility, and Corporate Innovation // Journal of Financial and Quantitative Analysis (JFQA). 2015. Pp. 1–88. http://dx.doi.org/10.2139/ssrn.2654416

37. *Lee C., Park G., Marhold K., Kang J.* Top management team's innovation-related characteristics and the firm's explorative R&D: an analysis based on patent data // Scientometrics. 2017. Vol. 111, Issue 2. Pp. 639–663. https://doi.org/10.1007/s11192-017-2322-1

38. *Camisón-Zornoza C., Lapiedra-Alcamí R., Segarra-Ciprés M., Boronat-Navarro M.* A Meta-analysis of Innovation and Organizational Size // Organization Studies. 2004. Vol. 25, Issue 3. Pp. 331–361. https://doi.org/10.1177/0170840604040039

39. *Barrena-Martínez J., Cricelli L., Ferrándiz E., Greco M., Grimaldi M.* Joint forces: Towards an integration of intellectual capital theory and the open innovation paradigm // Journal of Business Research. 2020. Vol. 112. Pp. 261–270. https://doi.org/10.1016/j.jbusres.2019.10.029

40. *Cruz-Cázares C., Bayona-Sáez C., García-Marco T.* You can't manage right what you can't measure well: Technological innovation efficiency // Research Policy. 2013. Vol. 42, Issue 6–7. Pp. 1239–1250. https://doi.org/10.1016/j.respol.2013.03.012

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