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# ASSESSMENT OF THE IMPACT OF TRANSACTIONS M&A ON INNOVATIVE INDICATORS OF THE COMPANY

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## ABSTRACT

*M&A on expenses R&D the method the difference of differences (DID – Difference-in-Difference) which founder Meyer B is considered is applied to assessment of the impact of transactions. [1995]. The ideas of this method comparison of the companies with various characteristics of expenses R&D before and after the transaction M&A lies. However, at simple comparison of these characteristics will not give effective impact assessments M&A. To avoid influence of other factors on change of expenses R&D, such as economic instability in the country, world shocks of supply and demand and others, besides the main group of the observed companies, to be entered control group. Each company from the main group the company analog from control group is selected so that the company of an analog had no transactions during the period in which the company had a transaction from the main group. Thus, the DID method compares a difference of results of the acquisitions and no acquisitions firms before acquisition. For this method it is necessary to prove the choice of control group – the companies which did not undergo acquisition process. The trial and error method of control group on index of coincidence (PSM – Propensity Score Matching)*

*[by The Central role ..., was for this purpose applied 1983 Rosenbaum P.]. Selection on the basis of mark assessment allows to define control group which on the main characteristics would not differ from group of the acquainted firms*

**Keywords:** Mergers and Acquisitions (M&A), R&D, innovation, the method the difference of differences, intellectual property, patents, publication activity.

**Cite this Article:** Alex Borodin, Natalia Kiseleva, Galina Panaedova, Irina Yakovenko and Mikhail Bilchak, Assessment of the Impact of Transactions M&A on Innovative Indicators of the Company, *International Journal of Mechanical Engineering and Technology*, 10(2), 2019, pp. 1085-1101.

<http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&IType=2>

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## 1. INTRODUCTION

In modern market economy the superactivity periods among transactions on merge and acquisition were periodically noted (M&A - Mergers and Acquisitions). Transactions of M&A play an important role in the course of reorganization of structure of the companies and their key indicators. For this reason recently pay attention to studying of an issue of influence of M&A on efficiency indicators in the fields of strategic management, the theory of the industry organization and finance more and more.

The market of pharmaceuticals is characterized by the developed competition connected with the large volume and a variety of medicines, considerable interchangeability of drugs among different producers, development of pharmacy chains. Such competitive environment induces the pharmaceutical companies on the new ways of development. As a result, the market in this sphere is characterized by high intensity of merges and acquisitions (Mergers and Acquisitions, M&A) which open to the companies additional opportunities. For example, in 2015 the market of the pharmaceutical and biotechnology industry was characterized by the high M&A level of activity [Global ..., 2016; IMAP]. It is important to note that the most large deal in the world in 2015 was between the pharmaceutical companies "Pfizer" and "Allegan" - \$184 billion.

The innovation indicators of the company first of all are understood as expenses on research and development (R&D – Research and Development Expanse) and other derivative indicators from them. The last 10 years the pharmaceutical industry takes the second place on R&D to expenses after the industry of electronics and in 2015 the total number of expenses, directed to researches made \$145 billion [The 2015 ..., 2015; Strategy&, PWC].

Expenses on R&D with high probability are subject to strong influence from restructuring of the industry [The Impact of ..., 1990; Hall]. On the one hand, transactions of M&A allow to expand to the companies the knowledge base (economy from scale) and to direct them to development of new medicines, thereby increasing the general welfare of people. On the other hand, the acquisition firm can have similar technology process or similar final goods – in this case the purpose of M&A is the mitigation of the competition and risk reduction for the acquisitions company connected with negative impact on future growth. In this case, consumers face overestimate of prices for products in the short-term period and reduction of incentives to introduction of innovations of the pharmaceutical companies in the long term.

Despite the above, results not numerous empirical a research in this area, available today, are very contradictory. Influence of M&A on R&D expenses strongly fluctuate in dependence as well as on branch of a research, and on the considered period.

## 2. LITERATURE REVIEW

Each company faces the choice of the development strategy. It can be natural growth at the expense of the potential of own assets of firm and increase in a share in the market or inorganic growth through transactions M&A. The first strategy can take rather long time while the second will be able perhaps to provide the company with rapid growth. It is especially relevant when the market grows with greater speed, than the company, in that case is not enough time for natural growth and firms make the choice for merge or acquisition.

In specialized literature, the terms "merge" and "acquisition" are often used in common and characterize the special economic relations. The financial and credit encyclopedic dictionary defines merges and acquisitions as group of financial transactions the purpose of which is merging of the organizations, the companies, etc. in uniform economic entity for obtaining competitive advantages and maximizing, in the long term, the cost of this subject [Financial and credit ..., 2002; Finance and statistics].

In works "Finance" of Stars. Baud and R. Merton [Finance, 2007; Williams] and "Bases of management of finance" of J. Van Horn [Bases of management of finance, 2003; Finance and statistics], merges and acquisitions is considered as the strategic decision in financial management which are sources of changes in structure of the capital of the company.

According to Gvardin S.V. [Merges and acquisition, 2013] merges and acquisitions are understood as restructuring of property of the company as a result of sale of divisions, alienations, subsidiaries and also full or partial acquisition of other organization.

However, both terms demand also separate consideration. In the Russian legislation, the term "merge" is treated as "emergence of new society by transfer of all rights and obligations of two or several societies to it with the termination of the last" [The Federal law ..., 2013]. In other words, merge is resulted by merging of several companies in one. At the same time there is one "getting" company which, as a rule, has more powerful economic potential and which acts as the initiator of the similar transaction.

In work E.V. Semenkova and N.B. Rudyk the term "acquisition" is defined as the paid transaction of which the transition of the property rights to the organization which in most cases is followed by replacement of management of the acquired company and change of its production and financial policy is result. The term "merge", according to authors, should be used in relation to "friendly acquisition" which is supported by management of the company purpose [The market of corporate control ... 2002; Finance and statistics].

Depamfilis D. in the work "Merges, acquisitions and other ways of restructuring of the company" calls acquisition process of formation of the company by the main owner of other company, due to acquisition of control over the last [Merges, acquisition ..., 2007; The Olympus is Business].

Today there are several classifications of transactions M&A. For example, they can be classified by the nature of integration of the companies, national identity of the united companies, the relation of management of the companies to the transaction, a way of association of potential, etc.

The type of the transaction depends as on the situation in the market, as well as on the business strategy of the companies. It is also necessary to consider the fact that transactions M&A have the features in the different countries or regions of the world.

The main classification M&A is based on the nature of integration of the company. According to this sign allocate:

- horizontal merges – merging of the firms which are belonging to one industry, making the same goods or carrying out the same stages of production. In this work such transactions at the level of the pharmaceutical industry are considered;

- vertical merges – merger of companies, the goods relating to the different industries, but connected by technological process of production. Such association allows the company to expand the activity, both on the previous production stages, and on the subsequent;
- patrimonial merges – merger of companies, producing the interconnected goods. For example, merging of the company making cameras with the company which is releasing a film;
- conglomerate merges – merger of companies, belonging to various industries without presence of any production community;
- conglomerate merges – merger of companies of various industries without presence of production community.
- In turn allocate three kinds of conglomerate merges:
  - merges to expansion of the grocery line - connection of not competing products for the purpose of increase in the range of goods;
  - merges to market expansion - acquisition of additional channels of product sales in geographical areas which were not served earlier;
  - the pure conglomerate merges which are not assuming any community.

Thus, transactions M&A are instruments of financial policy of the companies which purpose is achievement of competitive advantages in the market. In spite of the fact that merges and acquisitions it is extremely difficult and expensive process, their need is put by trends of development of the modern market.

Undoubtedly, the question of what is motives of merging of two companies in one sets thinking many. As already at an understanding stage that carrying out the transaction moves the issue of its expediency can be resolved. Having analyses experience of various Russian and foreign companies, it is possible to mark out the following motives.

First, this aspiration to gain synergetic effect which represents the additional cost which results from association. Can be expressed as economy from scale, economy of costs for research and development or effect of diversification. In other words the cumulative result of the united companies will significantly exceed results of separate actions of the companies. Also to be necessary to pay attention that if the acquisition company operates in the adjacent sphere, then economy from scale effect is supposed. If the company – the purpose larger and takes strong positions in the market, then it is possible to assume operational synergy. The majority of the made and made transactions in the M&A market mean synergy and consist for the purpose of its receiving. However not always synergetic benefits are reached.

Other often found motive is accessions of the underestimated public company. But in this case, to be convinced that the company is really underestimated, and there are no other reasons in its underestimated cost of the acquisition company it is necessary to carry out independent preliminary estimate. Accession of the enterprise with poor control has similar motivation. Difference only that in case of undervaluation the underestimated actual cost is caused conjecture the stock market, and in case of management – its inefficiency and irrationality.

One more motive is elimination of competitors and increase in the exclusive power in the market of the company buyer. This motive is characterized by desire of the company to increase the influence in the market. As a result of the transaction the attached company is not a competitor any more, and sometimes can be acquired just for the purpose of closing.

Author of Röllner L. - H. and others in work of "Efficiency gains from mergers" incline that typical motives of merge disappear under the guise of achievement and strengthening of

the market power and increase in efficiency due to achievement of economy on effect of scale [Efficiency gains from mergers, 2001; European Economy]. Economy from scale in microeconomics is understood as cost reduction on a unit of production at production integration [Nureev R. M., 2010; Microeconomics Course]. However in financial economy statements that transactions on merge and absorption are directed to correction of internal firms not of efficiency, to the solution of the problems connected with agency costs and for fight against imperfection of the market the capitals meet [Market for corporate control, 1983 meet; Journal of Financial Economics].

In comparison with a large number of the scientific literature devoted to influence of transactions M&A on financial and economic performance of the companies and their efficiency, the number of the researches directed to influence studying M&A on scientific activity of the companies are not enough.

Let's begin with the main theories following from scope of influence of transactions on innovations of the companies. At first we will consider theories which speak about negative dependence between transactions on merge and expenses on researches. The majority of such theories speak about inefficiency of the capital markets where transactions M&A influence directly the size of a financial leverage (increasing it), thereby increasing the alternative cost of investment into research and development. As a result investments into research and development of the participating companies of transactions decrease. Therefore there are three hypotheses:

1. In strict financial the frame, M&A and R&D are two alternatives which demand financing and are presented at choice of the company. For example, if managers of firm are engaged in preparation for carrying out the transaction M&A, then from their party is given to less attention to control and management of research projects. As a result of carrying out the transaction M&A plans for development of researches can be moved for other terms, thereby expenses on R&D will fall.

2. On condition of efficiency of corporate control, M&A can act as disciplinary control over managers of the absorbed company. Under pressure of the transaction of merge, managers will operate less free cash flows of the company and to invest risky projects less. These projects can directly belong to scientific activity. As result, transactions on merge and acquisition will reduce expenses on R&D.

3. Transactions M&A constantly face a problem of deduction of the leading positions of the acquainting company over acquainted. That managers of the acquainted company lose the property right to receiving profit on investments into researches they will be less interested in the in increases in expenses on future opening and developments [Breach of trust in takeovers ..., 1995; Journal of Industrial Economics].

Thus, not only change of a financial leverage of the company, but also change of structure of a project portfolio R&D involves decrease in expenses on research and development. Managers, expecting a possibility of carrying out the transaction M&A, invest in short-term a little expensive projects in the sphere of research and development more, than in long-term [Sources of value creation ..., 1990; Strategic Management Journal]. The main idea put in theoretical hypotheses of this subject says about pressure of transactions M&A on managers that it involves decrease in long-term investments into research and development.

Speaking about positive impact of transactions M&A, there are following theories:

1. Depending on negotiations and the borrowing positions, managers of the acquisitioned company can gain a part of income from the transaction from managers of the acquisitions company. This phenomenon is called "golden parachute". Thereby, the company which will

want to be the sold larger company will increase investments into research and development it is to become rather an object for acquisition.

2. At the hostile relations between the companies, managers can increase expenses on research and development to strengthen the positions at negotiations on a transaction occasion M&A [Management entrenchment: case ..., 1989; Journal of Financial Economics].

As a result on theoretical aspects of this problem it is possible to conclude that the strong base R&D is an important factor of success of the transaction M&A for assessment of the potential purpose and obtaining synergetic effect of association of innovations of two companies. Besides, higher tendency of managers to risk can affect the number of projects in the sphere R&D.

### 3. EMPIRICAL PREDICTIONS AND METHODOLOGY

#### 3.1. Hypotheses

From the analysis of already available researches in this subject today, it is possible to reveal key indicators of the innovation activity most of which often all met in works. These are indicators of so-called intra-corporate expenses on research and development (R&D inputs) and externally - signature indicators (R&D outputs). Proceeding from logic of Hitt, Hoskison and Ireland (1990) of the transaction on M&A replace expenses on R&D, the companies can be more attractive also less risky and invest money in purchase of other company, to thereby cut down investments into research and development. Besides, purchase of the company is an immediate growth of a share of the market, emergence of new opportunities that it can be more favorable, than increase in expenses on new researches. Thus, we will carry indicators of expenses on research and development and also the relation of expenses on research and development to the revenue of the company (R&Dintensity) to intra-corporate indicators of the innovation activity.

*Hypothesis 1:* Existence of negative communication between transactions on merge and acquisition and intra-corporate indicators of innovation, expressed in expenses on research and development and in expenses on research and development rated in revenue size.

Transactions of merge and acquisition can also influence external indicators of the innovation activity of firms. Patent level shows extent of commercialization of new drug or process of production. M&A can interfere and change strategy for development of new technologies and patenting of new medicines. Managers of those companies who participate in transactions of M&A can be more interested in an extensive way development, that to pay less attention to development of internal researches and developments. As result – decrease in the general level of patent activity.

*Hypothesis 2:* Existence of negative communication between transactions on merge and acquisition and externally signature the innovation indicator expressed concerning the general number of patents to expenses on research and development.

### 4. METHODOLOGY

For drawing up the list of the pharmaceutical companies, first of all transactions need to address statistics on M&A in the field of pharmaceuticals. This statistics was taken from the terminal of Bloomberg. The M&A base contains information on 8,469 public companies in the field of pharmaceuticals from 2000 for 2010. Further the largest companies on standard industry classification (SIC) 2834 and 2835, on the example of Ornaghi C (2009). For more exact analysis, the received selection of 998 companies, was limited by the transaction size M&A. The announced size of the transaction of the company should not have been less than \$10 million. It was made to discard all insignificant transactions of the companies which will

not affect changes in expenses R&D in any way. All financial performance on the companies is presented in currency US\$. Only large, significant deals M&A among the pharmaceutical companies because only they can influence further development of researches of the absorbing company are of interest to the analysis and change costs breakdown R&D. As a result, having thrown out the companies on indicators in which big cases were absent, final selection consisted of 129 pharmaceutical companies which participated in large deals M&A during 2000 - 2010.

For a research, as control variables the following indicators of the innovation activity of the enterprises were selected:

- The RD variable – Research&Development Expense; expenses on research and development;
- The RDint variable – Research&Development Intensity; intensity of expenses on research and development; the indicator is calculated as the relation:  $\frac{\text{Research\&Development Expense}}{\text{Total Revenue}}$ ;
- The Patents variable – proxy the variable characterizing productivity of patent activity of the companies and calculated as the relation of the general number of patents to expenses on research and development  $\frac{\text{Number of Patents}_t}{\text{Research\&Development Expense}_t}$ . The variable reflects effectiveness of expenses on research and development; data on patents are provided by the leading world patent base Orbit.com. When using data, the number of patents were selected by date of submission of documents on the patent (Application date) because the actual time when the research was made, is closer to date of submission of documents on the patent, than to the date of receipt of a grant. It happens because of dead time for consideration of requests by patent department (Hall B.H. and etc. 2001 "The Nber Patents ...").
- Because of a possibility of effect of influence of transactions M&A on the level of innovations of the companies – the fact of merge can affect change of indicators not in a year, and in 3 years after M&A. Therefore, all control variables were calculated as change of an indicator for the period from  $t-1$  to  $t+1$ ,  $t+2$ ,  $t+3$  to trace influence of transactions M&A in a year, in 2 years and in 3 years after the transaction (Desyllas P. "Do High Technology ..."). For example, the indicator of level of expenses of research and development is calculated as:

• *Influence of transactions on an indicator in a year later M&A –*

$$RD_{t-1;t+1} = \frac{RD_{t+1} - RD_{t-1}}{RD_{t-1}};$$

• *Influence of transactions on an indicator in 2 years after M&A –*

$$RD_{t-1;t+2} = \frac{RD_{t+2} - RD_{t-1}}{RD_{t-1}};$$

• *Influence of transactions on an indicator in 3 years after M&A –*

$$RD_{t-1;t+3} = \frac{RD_{t+3} - RD_{t-1}}{RD_{t-1}}.$$

Calculations for indicators of RDint and Patents were similarly made.

As independent variables in the Propensity Score Matching model were used:

- RDint variable – Research&Development Intensity; intensity of expenses on research and development; the indicator is calculated as the relation:  $\frac{\text{Research\&Development Expense}_t}{\text{Total Revenue}_t}$ ;

- *Size* variable – proxy a variable, which represents natural logarithm of total assets  $Ln(Total Assets_t)$  (Desyllas P. “Do High Technology...”).;
- *Growth* variable – proxy a variable, which represents the annual growth of total assets of the company  $\frac{Total Assets_t - Total Assets_{t-1}}{Total Assets_{t-1}}$ ;
- *Tobin’s Q ratio* variable – the relation market the cost of assets to their recovered cost is calculated as; because of the fact that the most part of assets of the pharmaceutical companies is concluded not in a physical equivalent, and in non-material, this variable most likely will be sensitive on fluctuations of intangible assets. Owing to it, the firm which expects the expiration of important patents will have level below Tobin’s Q ratio in comparison with similar competitors ( Danzon M. and etc. “Mergers and Acquisitions...”).
- *Profitability* variable – proxy variable operating income which is calculated as the relation of a profit before taxes and percent to total assets  $\frac{EBIT_t}{Total Assets_t}$ ;

The dependent variable in the PSM model is presented in the form of dummy variable (dummy),  $ACQ_{it} = \{1,0\}$ , which accepts value {1} if at company i the transaction M&A in the period of t is observed, and {0} at the return.

The descriptive statistics of observed indicators of the innovation activity of the companies during 2000 - 2010 is given below:

	<b>Variable</b>	<b>No</b>	<b>Mean</b>	<b>S.D</b>
1	<b>Change in RD</b>			
	From <i>t-1</i> to <i>t+1</i>	897	2.109	46.140
	From <i>t-1</i> to <i>t+2</i>	870	3.493	74.378
	From <i>t-1</i> to <i>t+3</i>	841	3.063	49.479
2	<b>Change in <math>RD_{int}</math></b>			
	From <i>t-1</i> to <i>t+1</i>	870	.743	8.781
	From <i>t-1</i> to <i>t+2</i>	843	3.123	62.710
	From <i>t-1</i> to <i>t+3</i>	815	2.889	52.173
3	<b>Change in Patents</b>			
	From <i>t-1</i> to <i>t+1</i>	868	-6.045	140.060
	From <i>t-1</i> to <i>t+2</i>	832	-3.230	135.025
	From <i>t-1</i> to <i>t+3</i>	810	2.030	188.622
4	<b>Revenue</b>	1182	3687.634	9149.791
5	<b>EBIT</b>	1188	819.563	2400.130
6	<b>Tobin’s Q</b>	1109	2.982	4.828
7	<b>Total Assets</b>	987	8.337	119.106

Trial and error method of control group on the index of coincidence (PSM method). As one of tools of the empirical analysis in this work a method of probabilistic compliances. This method allows to break the available selection thus as though initially existed control (control group) and the main group (treatment group) of observations. To control group the companies which participated in transactions M&A during the different periods belong, and the companies which did not take part in merges and acquisitions during the same periods treat the main group.

As earlier it was mentioned, besides the main group of the observed companies, to be entered control group. Each company from the main group the company analog from control group proceeding from various characteristics is selected. For this method it is necessary to prove the choice of control group – the companies which did not undergo acquisition process.

It is more expedient to calculate the uniform index for selection of the companies of analogs which will be based on a number of characteristics of firms (the size of firm, Q Tobin, a financial leverage, profitability of assets, etc.). Use of a trial and error method of control group on index of coincidence which founders consider Rosenbaum and Rubin (1983) allows to calculate the probability of firm to take part in the transaction M&A, based on various characteristics. Respectively, for a start we will determine the probability of each firm of participation in the transaction M&A using logistic regression of a look:

$$P(ACQ_{i,t} = 1) = F(X'_{i,t-1}\beta) = \frac{1}{(1+e^{-X'_{i,t-1}\beta})}$$

$P(ACQ_{i,t} = 1)$  – it is probability that company  $i$  participates in the transaction M&A (the fact existence of the transaction at company  $i$  in the period of  $t$  is set by a dummy variable  $ACQ_{i,t} = 1$  – y the companies the transaction in the period of  $t$  was observed,  $ACQ_{i,t} = 0$  – at the company the transaction in the period of  $t$  was not observed);

$F(X'_{i,t-1}\beta)$  – the logistic function lying in model;

$X'_{i,t-1}$  – it is a vector of the independent characteristics observed in the period of  $t-1$  to the transaction M&A;

$\beta$  – vector of coefficients of regression.

The vector of  $X$  includes such indicators as intensity of expenses on R&D intensity research and development ( $RD_{int}$  – the relation R&D expenses to the revenue of the company, the size of firm (size – a proxy a variable of natural logarithm of total assets of the company), growth (growth – a proxy a variable of annual growth of total assets), Q Tobins Q, profitability (profitability – EBIT relation to total sales of the company) in the period of transaction  $t-1$  M&A. This set of regressors is based on the analysis of the previous researches, such as Conyon, etc., 2002, Harris and Robinson, 2002, by Dessylas, etc. 2010. The descriptive statistics and correlation matrix on these variables is given below:

	Variable	Mean	S.D	1	2	3	4	5	6
1	ACQ	.138	.345	1.000					
2	$RD_{int}$	8.901	21.448	-.025	1.000				
3	Size	6.384	2.330	.132	-.096	1.000			
4	Tobin's Q	3.080	4.892	.029	.039	-.015	1.000		
5	Growth	.137	20.332	-.014	.007	-.065	0.068	1.000	
6	Profitability	-9.715	130.422	0.028	-.034	.104	-.039	-.009	1.000

For each observation the individual probability of participation in the transaction M&A in the period of  $t$  (Propensity Score) pays off. After that the procedure of search of compliances (Matching) where observation from control group is compared to each observation with the closest individual probability of participation in the transaction from the group which received influence (group of companies, participating in transactions of merge and absorption) is carried out. Results of model of selection of control group on index of coincidence are given below:

	<b>Regresses</b>	<b>Coefficient</b>
1	Cons	-1.486*** (.191)
3	RD <sub>int; t-1</sub>	.124* (.006)
4	Size <sub>t-1</sub>	.082*** (.023)
5	Tobin's Q <sub>t-1</sub>	-.008 (.021)
6	Growth <sub>t-1</sub>	-.002 (.013)
7	Profitability <sub>t-1</sub>	.052 (.072)
Number of observations		1419
Number of merger		196
Chi-squared		15.66***
Pseudo R2		.020
Log likelihood		-378.800

\* p<0.1; \*\* p<0.01; \*\*\* p<0.001

Based on the received estimates, the companies which participate in transactions M&A are characterized by distinctive signs of different indicators. For example, the decision of the company to participate in the transaction in M&A next year  $t+1$  is positively influenced by such indicators as  $RD_{int}$ , the size of firm,  $EBIT$  relation coefficient to *Revenue*. However, such indicators of firms as growth and Q Tobin negatively influence decisions on participation in transactions of merge and absorption. It is logical that the indicator Q Tobin at the companies is higher, the more is available for them working patents and the less companies need process M&A. Similarly and with growth of the company, expressed in annual growth of total assets – what with big rates the firm grows, that with smaller probability she will resort to the transaction M&A.

Important point, at selection of the companies analogs, is the ratio of the main characteristics of the companies of the main and control group. If these characteristics differ, then undoubtedly this the factor will affect the shift of the received estimates (Hirano, etc., 2002). For this reason, in work of Rosenbaum and Rubin (1983) the trial and error method of control group on index of coincidence which allows to pick up to the main group control, with adjacent characteristics is described.

Further, based on the received results of probability of participation in the transaction of the PSM method, the problem of absence of the company of an analog to the company in the main group is inevitable. This problem is also described in the research Heckman, etc., 1997. Observations, the calculated  $P_i$  probability for which exceeds the maximum value of probability of the companies from control group, or it appears below the minimum value of probability of the companies from control group, were excluded.

The trial and error method of a check group on index of coincidence demands execution of a condition of balance of data, that is the interesting characteristics for assessment of the index should be evenly distributed between a check and main group. The table with results of testing of balance of data is given below. In general, after comparison of the companies, a difference in mean values of the variables of the innovation activity of the companies interesting us statistically we do not mean. Also the criterion of uniformity of Kolmogorov-

Smirnova was applied to definition of equality of distributions of two groups of observations. The test result does not reject a hypothesis of equality of distributions in a check and main group of diggings [Rosenbaum and Rubin (1985); Guo and Fraser (2010)].

	Variable	Sample	Treated	Control	Mean Difference (P-value)
1	RD	Unmatched	704.236	708.841	.054***
		Matched	701.023	705.051	.412
2	RD <sub>intensity</sub>	Unmatched	6.458	8.705	.023**
		Matched	6.574	6.935	.320
3	Patents	Unmatched	.052	.084	.004**
		Matched	.054	.065	.226

Since work of Ashenfelter O., Card D., (1985: "Using the Longitudinal Structure of Earnings to Estimate the Effect of Training Programs"), estimation by method a difference-differences in the analysis of influence of the program on group of observations was widely adopted.

After each company from the main group the company analog from control group is picked up, it is necessary to track the interesting effect of influence of transactions M&A on R&D indicators. Let  $Type = \{1; 0\}$  means that the firm participates in the transaction M&A and treats the main group of companies –  $Type = 1$ . Similarly,  $Type = 0$  means that the company treats control group and during the considered period it did not observe the transaction with other company. Let  $I$  designate interesting us the result of change of expenses on research and development or change of level of patents. Let  $Treat = \{Yes; No\}$  shows existence of the transaction M&A at the company during the considered period. Characteristic of  $Period = \{1; 0\}$  corresponds to the period after the transaction M&A ( $Period = 1$  indicator) and to the period to the transaction ( $Period = 0$  indicator). Index  $E$  shows the average or expected outcome. Therefore we receive the following equation which needs to be estimated for identification of influence of transactions M&A on innovative indicators of the companies:

$$\Delta = E[I_i^{Treat=Yes} | Type = 1, Period = 1] - E[I_i^{Treat=No} | Type = 1, Period = 1] \quad (1)$$

The received outcome  $\Delta$  designates a difference between changes of indicators of research activity of the companies which in the first case participated in the transaction M&A, and in the second if they did not participate in the transaction. But to receive change of the interesting indicators at the companies which participated in the transaction under the condition assuming nonparticipations of the companies in these transactions – it is contradictory. For this reason, in work the described comparison method for definition of an indicator  $E[I_i^{Treat=No} | M = 1, Period = 1]$ . The trial and error method of control group on the index of coincidence (PSM method) assumes equivalence of outcomes of the companies which are participating and not participating in transactions:

$$E[I_i^{Treat=No} | Type = 1, Period = 1] - E[I_i^{Treat=No} | Type = 1, Period = 0] = E[I_i^{Treat=No} | Type = 0, Period = 1] - E[I_i^{Treat=No} | Type = 0, Period = 0], \quad (2)$$

Where the second part of equality designates the difference of changes of indicators of innovation of the companies which are not participating in transactions, but the having similar signs with the main group of companies. Having substituted  $E[I_i^{Treat=No} | M = 1, Period = 1]$  from the equation (2) in the equation (1), we will receive the following interrelation:

$$E[I_i^{Treat=Yes} | Type = 1, Period = 1] - E[I_i^{Treat=No} | Type = 1, Period = 0] - E[I_i^{Treat=No} | Type = 0, Period = 1] + E[I_i^{Treat=No} | Type = 0, Period = 0] \quad (3)$$

From equality (3),  $E[I_i^{Treat=No} | Type = 1, Period = 0]$  is the level of an observed variable at the main group of companies in the period of  $Period=0$ , to the transaction M&A.

Therefore equality is fair:

$$E[I_i^{Treat=No} | Type = 1, Period = 0] = E[I_i^{Treat=Yes} | Type = 1, Period = 0] \quad (4)$$

Now, knowing equality (4), we can simplify the equation (3) and lead it to the following simplified look:

$$\Delta = (I_{Type=1,After} - I_{Type=1,Before}) - (I_{Type=0,After} - I_{Type=0,Before}) \quad (5)$$

Modifying the equation (3) in the work with application of a trial and error method of control group on index of coincidence, Rosenbaum and Rubin receives the following result:

$$\Delta = E_{P(X)}[E\{I_{Period=1} | P(AQC_{i,t} = 1), Type = 1\} - E\{I_{Period=0} | P(AQC_{i,t} = 1), Type = 0\}] = E_{P(X)}[E\{z_1 | P(AQC_{i,t} = 1)\} - E\{z_0 | P(AQC_{i,t} = 1)\}] = E[z_1 - z_0] \quad (6)$$

Where  $P(X)$  is balanced index of coincidence (probability of the company to participate in the transaction M&A).

If  $\Delta < 0$ , then dynamics of innovative indicators (Rd, Rdint, Patents) is lower than the companies participating in transactions M&A that proves negative impact of these of synergy. If  $\Delta > 0$ , then change of observed indicators at the companies of the main group is higher, than at the companies from control group which are not participating in merges and acquisitions. Then the hypothesis of positive influence of transactions M&A on R&D the pharmaceutical companies will be confirmed.

The equation (5) which is received thanks to a trial and error method of control and main group is result of a method a difference differences (Difference-in-Difference method, DID). To find value  $\Delta$  which is responsible for existence of impact of merges on innovative indicators of the companies it is necessary to construct the following regression:

$$I_{it} = \beta_0 + \beta_1 TREAT_{it} + \beta_2 \times TYPE_i + \beta_3 \times TREAT_{it} TYPE_{it} + \varepsilon_{it} \quad (7)$$

the  $TREAT=\{1,0\}$  variable is responsible for the period to ( $TREAT=0$ ) and later ( $TREAT=1$ ) transactions M&A; the  $TYPE$  variable characterizes to what group the company – treats the main or control. For the analysis it is necessary to estimate value of coefficient  $\beta_3$ . For an explanation of this solution, we will give below estimates of all coefficients of the equation (7):

$$\widehat{\beta}_0 = (I | TREAT = 0, TYPE = 0)$$

$$\widehat{\beta}_1 = (I | TREAT = 1, TYPE = 0) - (I | TREAT = 0, TYPE = 0)$$

$$\widehat{\beta}_2 = (I | TREAT = 0, TYPE = 1) - (I | TREAT = 0, TYPE = 0)$$

$$\widehat{\beta}_3 = [(I | TREAT = 1, TYPE = 1) - (I | TREAT = 0, TYPE = 1)] - [(I | TREAT = 1, TYPE = 0) - (I | TREAT = 0, TYPE = 0)],$$

where  $\widehat{\beta}_3$  it is equivalent

$$\Delta = (I_{Type=1,After} - I_{Type=1,Before}) - (I_{Type=0,After} - I_{Type=0,Before})$$

The value  $\beta_3$  is also equivalent to value  $\Delta$  - it is and there is a sign of influence of transactions of merges and acquisition on innovative indicators of the companies.

Therefore, within the research the following expanded hypotheses which were mentioned in Chapter 2.1 are made and checked:

Hypothesis 1.1 Transactions M&A negatively influence change of expenses on RD research and development during  $t-1$  to  $t+1$ ;

Hypothesis 1.2 Transactions M&A negatively influence change of expenses on RD research and development during  $t-1$  to  $t+2$ ;

Hypothesis 1.3 Transactions M&A negatively influence change of expenses on RD research and development during  $t-1$  to  $t+3$ ;

Hypothesis 1.4 Transactions M&A negatively influence change of intensity of expenses on  $RD_{int}$  research and development during  $t-1$  to  $t+1$ ;

Hypothesis 1.5 Transactions M&A negatively influence change of intensity of expenses on  $RD_{int}$  research and development during  $t-1$  to  $t+2$ ;

Hypothesis 1.6 Transactions M&A negatively influence change of intensity of expenses on  $RD_{int}$  research and development during  $t-1$  to  $t+3$ ;

Hypothesis 2.1 Transactions M&A negatively influence change of patent efficiency of *Patents* during  $t-1$  to  $t+1$ ;

Hypothesis 2.2 Transactions M&A negatively influence change of patent efficiency of *Patents* during  $t-1$  to  $t+2$ ;

Hypothesis 2.3 Transactions M&A negatively influence change of patent efficiency of *Patents* during  $t-1$  to  $t+3$ ;

As a result, in a research the main group of companies at which the transaction M&A during a certain period, and a check group was observed is used. Dependent variables are a change of indicators of the innovation activity of the company, different interpretations of an indicator of level of expenses of research and development and also a patent indicator of the companies. The following variables are taken for independent variables in the PSM models: intensity of expenses on R&D intensity research and development ( $R\&D_{int}$  – the relation R&D expenses to the revenue of the company, the size of firm (size – a proxy a variable of natural logarithm of total assets of the company), growth (growth – a proxy a variable of annual growth of total assets), Q Tobins Q, profitability (profitability – EBIT relation to total sales of the company).

## 5. DATA AND SAMPLE DESCRIPTION

In table the received results from equation Difference-in-Difference model assessment are reduced:

$$I_{it} = \beta_0 + \beta_1 TREAT_{it} + \beta_2 \times TYPE_i + \beta_3 \times TREAT_{it} \times TYPE_{it} + \varepsilon_{it}, \text{ where:}$$

$I_{it}$  - is the studied indicator showing on itself the impact of process of merges and acquisitions. It includes change of expenses on RD research and development, change in intensity of expenses on  $RD_{int}$  research and development, change in productivity of the patent environment of the companies, Patents;

*Treatment* – a variable is responsible for the considered period in which the dependent variable of  $I_{it}$  is observed: accepts value 1, during the period after the transaction M&A, and 0, during the period, the previous process of merge and acquisition;

Firm Type – the variable characterizes to what group the company – treats main (*Firm Type=1*) or control (*Firm Type=0*);

Treatment×Firm Type – characterizes extent of influence of transactions M&A on the studied indicator for a certain period.

With the purpose to trace a possibility of long-term influence of transactions M&A on the innovation indicators of the pharmaceutical companies, 3 periods were considered: 1 years, 2 years, 3 years (columns (1) – (2)).

In general, at the analysis of influence of transactions M&A on change of expenses on research and development of RD it is possible to notice negative significant impact. Process of the transaction negatively influences growth of expenses of the RD companies in 1 year and in 2 years after M&A in comparison with the companies analogs, not participating in the transaction at that time. At assessment positive influence in 3 years was received, however it is statistically not significant. The importance of coefficient before the Treatment variable for 10% significance value can be interpreted as bigger change of expenses of RD at the companies which are not participating in transactions because from the equation of regression (7) these companies have the statute of  $Type=0$ , respectively influence of the  $Treatment \times Firm\ Type$  variable vanishes, and the  $Type$  variable makes the positive contribution. Thereby at a check group the indicator of change of expenses on research and development in comparison with the companies participating in transactions M&A for the considered period increases.

Almost similar results are received at a research of influence of transactions on an indicator of intensity of the expenses directed to research and development. On average, at the companies participating in transactions M&A change of intensity of RD of expenses, in comparison with a check group of the companies is -.773 points lower. The importance of coefficient before the  $Treatment \times Firm\ Type$  variable is less than 5%. The negative impact on an indicator of intensity is traced also in 2 years after the transaction of merge and absorption (the importance of coefficient of influence -.997 for 10% significance value).

Impact on  $RD_{int}$  in 3 years after the transaction M&A did not show significant results, except the Treatment variable which influence, together with insignificance of other coefficients, does not yield any outputs and results.

In comparison with indicators of the innovation activity, connected with research expenses, the indicator of patent activity shows the return influence M&A. In 2 and 3 years after process of merger of companies, the relation of number of patents to research expenses increases, in comparison with the companies, not participating in transactions. Besides, in 3 years this influence is more, than in 2 years. It is connected not only with big coefficients of the  $Treatment \times Firm$  variable explaining influence M&A, but also with negatively significant coefficient of distribution of the company to the main or to a check group. In the main group, this coefficient underestimates growth of patent activity of the pharmaceutical companies in comparison with the companies from a check group.

	Variable	From $t-1$ to $t+1$ (1)	From $t-1$ to $t+2$ (2)	From $t-1$ to $t+3$ (3)
1	Change in RD			
	Constant	3.071*** (1.224)	-.980* (.390)	-3.044*** (1.263)
	Treatment	.553* (.234)	.472* (.238)	.390 (.505)
	Firm Type	-.164** (.112)	.493 (.623)	-1.066 (.834)
	Treatment×Firm Type	-.159* (.080)	-.318** (.122)	.169 (.621)
	Observations	781	756	725
	R-squared	.48	.44	.39
2	Change in $RD_{int}$			

	Variable	From <i>t-1</i> to <i>t+1</i> (1)	From <i>t-1</i> to <i>t+2</i> (2)	From <i>t-1</i> to <i>t+3</i> (3)
	Constant	-4.652*** (.356)	-3.243*** (.290)	-1.503 (1.063)
	Treatment	.345* (.194)	.528 (.702)	.684** (.201)
	Firm Type	.332 (.652)	.294*** (.125)	1.308 (.843)
	Treatment×Firm Type	-.773** (.245)	-.997* (.324)	0.740 (.844)
	Observations	779	753	721
	R-squared	.52	.48	.38
3	Change in <i>Patents</i>			
	Constant	-.088 (1.178)	.056 (1.152)	-1.253 (2.374)
	Treatment	.600*** (.288)	.504** (.223)	.478* (.195)
	Firm Type	-.175** (.086)	-.285*** (.170)	.683 (.505)
	Treatment×Firm Type	-1.075 (.883)	1.232* (.436)	1.882* (.723)
	Observations	772	769	711
	R-squared	.72	.57	.44

\*  $p < 0.1$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$

Summing up the results of the received results of a research, transactions of merge and acquisition among the pharmaceutical companies during 2000 - 2010 influence in such a way that the level of innovative activity 10 times less the companies which are not participating in transactions. Having received statistically significant indicators, it is possible to speak about the negative impact of process M&A on research expenses of the companies and on the rated size of these expenses on revenue in the period of 1 period and 2 years after the transaction. However increase in patent activity in 2 and 3 years after M&A is revealed. That is with acquisition of the new company, there is an insignificant exchange of knowledge in the form of development of patent activity, however the general development of research and development and delay of growth of expenses on research and development slows down. These results can correspond and contradict the previous researches, described in the head above. However, It should be noted that assessments of the impact of process M&A strongly depend the industries, a time span, the amount of selection and other static economic factors.

## 6. CONCLUSION

This work considers relationship of cause and effect of merges and acquisitions and activity in the sphere of research and development. She investigates the potential impact of merges and tries to answer a question whether influence M&A at the level of the pharmaceutical industry research activity. In the 1999th the wave M&A captured the industry and proceeds still. The foundation for this wave was laid by large deals between SmithKline Beckman and Beecham Group, Bristol-Myers and Squibb Corp, Pfizer and Pharmacia Corp. At the same time consequences of processes of restructuring on investment into technologies have basic value in that degree in which are considered as research and development as the main source technological change.

In work the relevance of the matter at the level of the industry is confirmed. On the basis of selection of the largest pharmaceutical companies participating in process of purchase of strategically important companies it is revealed that M&A have statistically significant negative impact on activity in the sphere of research and development of the absorbed firms. At the same time, transactions influence short-term investments into research and development (reduction of R&D inputs in one and two years, after the transaction M&A). Impact on expenses of researches in 3 years after the transaction was statistically insignificant.

The positive contribution to development of patent activity of the companies, the merges which underwent process and acquisition is also revealed. This effect is shown at long-term influence M&A on patent activity of the company – in three years after transaction.

If to speak about possible further researches in this subject, then there is a question connected by the factors influencing the decision of the companies to come to the transaction M&A. As a rule, firms participate in merge and acquisition for increase in their competitive capacities or to raise the innovative capital, other firms on the contrary, increase the innovative indicators that more likely other company got it. While the decision of other firms is influenced absolutely by other factors. In the available works transactions M&A in total at the moment are considered, without dividing them on the causes.

Besides it is interesting to track further shocks of the upset industry because in one research attention was not paid to this feature. Therefore the matter remains relevant for a further contribution to influence studying M&A and the level of innovations of the companies.

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