

# A Complex Algorithm for Selecting Instruments to Finance Mergers and Acquisitions

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**Abstract**—The study suggests formalized algorithm that allows to make an informed choice of instruments for financing M&A transactions. This algorithm includes following several stages: identification of the limiting factor; determination of the anticipated structure of settlements for the M&A transaction; formation of a financial instruments parameters set to use for the instruments' comparison; determination of specific weights of the selected parameters of the M&A financial instruments; identification of “preferable” values of financial instruments' parameters; comparison of the “preferred” financial instruments parameters with their actual or potentially possible parameters; making choice of the instruments for financing the M&A transaction. Approbation of the algorithm is done using the example of JSC “Agrofirma Volga”, acting as a buyer company, and JSC “Zorinskoye”, acting as a target company.

**Index Terms**—mergers and acquisitions, M&A transactions, financial instruments, computer modeling

## I. INTRODUCTION AND LITERATURE REVIEW

In the context of increasing competition, one of the most common long-term strategies for a company (regardless of a business segment or scale) is a strategy focused on participation in mergers and acquisitions (M&A).

In the financial and economic literature M&A transactions are investigated either in the general theoretical context (as in the works of E. Campbell, K. Luchs [1], T. J. Galpin, M. Herndon [2], S. F. Reed, A. R. Lajoux [3], P. Gaughan [4]), or on the contrary, scientists' interests are narrowed to very specific issues. E.g., the motives of M&A participants are examined by F. Trautwein [5], B. Jovanovic, P. Rousseau [6], J. Alexandridis, K. Mavrovitis, N. Travlos [7]; the estimation of the company's value during M&A is an matter of scientific interest of H. Bieshaar, J. Knight, A. van Wassenae [8], F. C. Evans, D. M. Bishop [9], M. Nagano, Y. Yuan [10]; the efficiency of the M&A transactions is investigated by K. Ramaswamy [11], N. Rani, S. S. Yadav, P. K. Jain [12], E. Pablo [13] and several other researchers.

Still, the issue of choosing tools for financing M&A transactions is not sufficiently investigated; in particular, many researchers, recognizing its importance and relevance, prefer to consider this process in the most simplistic terms (they often simply name financial instruments that may be used in the framework of such transactions). In fact, we can talk about the dominance of the “intuitive approach” to the study of this

issue, which suggests that the choice of instruments to finance such transactions is the sole prerogative of the transaction's parties, and the decision to use specific financial instruments is made primarily by the buyercompany.

The complete prevalence of such an approach leads to the fact that there are practically no “profile” studies in this area, e.g., studies that suggest formalized mathematical and, especially, computer algorithms or models allowing to make an informed choice of instruments for financing M&A transactions [14]. To overcome this shortcoming, we think it necessary to develop a comprehensive algorithm for the selection of instruments for financing M&A transactions.

## II. ALGORITHM FOR SELECTING TOOLS TO FINANCE M&A TRANSACTIONS

In our opinion, at *the first stage* of this algorithm the limiting factor that is critical for the transaction should be identified. The main limiting factor for a particular transaction is being chosen from a closed list of factors identified on the basis of analysis of transactions in the Russian M&A market in 2015–2017. The factors are:

- 1) the transaction scale factor, which is focused on the availability of financing instruments ( $L_S$ );
- 2) the time factor that takes into account the speed at which financial resources can be accumulated ( $L_T$ );
- 3) the cost factor that takes into account the cost of the resources accumulation ( $L_C$ );
- 4) the individual preferences factor, assuming the transaction participants have priorities in choosing the instruments for the transaction financing ( $L_P$ ).

The limiting factor is identified by the transaction parties directly and determines the formation of “preferable” requirements for financial instruments that can be used to finance the transaction.

At *the second stage* the anticipated structure of settlements for the M&A transaction is determined. The structure of the transaction settlements is also determined by the transaction parties, and it may assume:

- 1) one-stage settlement ( $t_{n_i} = 1$  where  $t_{n_i}$  is the number of settlement tranches for the transaction, which takes only integer values);

- 2) stage-by-stage settlement ( $t_{n_i} > 1$ ), with settlement tranches can have both conditional and unconditional character.

In one-stage settlement, the mathematical problem of choosing financing instruments is solved once, while in case of step-by-step settlement the problem acquires a sequential iterative character, and the number of iterations is numerically equal to the number of settlement tranches.

At the *third stage* of the algorithm, a financial instruments parameters set that is used for the instruments' comparison is being formed. When forming such a set, it is expediently to apply the parameters of financial instruments that are uniquely described by quantitative indicators ( $x_{F_i}$ ), while the presence of a parameter reflecting the influence of the limiting factor, which is of fundamental importance for the transaction ( $x_{LF_i}$ ), is mandatory.

The choice of the parameters used is based on ranked expert assessments as follows:

- 1) several expert groups equal in number are being formed ( $m$  is the total number of experts;  $m_g$  is the number of experts in each group, and  $m_1 = m_2 = \dots = m_u$ , where  $u$  is the number of expert groups);
- 2) each expert group independently forms the widest possible set of financial instruments' parameters;
- 3) the formed sets of parameters are compared to identify the parameters that are common ("crossed") for all sets ( $n$ );
- 4) the selected common parameters are ranked by all experts, with the smallest rank equal to 1 ( $r_{\min} = 1$ ), and the largest one equal to the number of considered parameters ( $r_{\max} = n$ ), with  $v = \sum r_j$ ;
- 5) within each expert group, the consistency of expert opinions is checked with the use of the Kendall concordance coefficient:

$$W_{g_j} = \frac{12S_{g_j}}{m_{g_j}^2 (n^3 - n)}, \quad (1)$$

where  $W_{g_j}$  is the concordance coefficient for the expert group;

$S_{g_j}$  is the sum of the deviations squares of the ranks' sums for an expert group, defined by the formula:

$$S_{g_j} = \sum_{i=1}^n (r_{g_{ij}} - \bar{r}_{g_{ij}})^2; \quad (2)$$

- 6) the significance of  $W_{g_j}$  is checked using the criterion  $\chi^2$ , which involves comparing the empirical value of the criterion ( $\chi_{Eg_j}^2$ ) with its critical value ( $\chi_{CRg_j}^2$ ) for a given significance level ( $\alpha$ ) and the number of degrees of freedom ( $n - 1$ ):

$$\chi_{Eg_j}^2 = \frac{12S_{g_j}}{m_{g_j} (n^2 + n)}; \quad (3)$$

If  $\chi_{Eg_j}^2 > \chi_{CRg_j}^2$ , then  $W_{g_j}$  is considered significant, and expert opinions are consistent;

- 7) with the consistency of expert opinions in all expert groups, the average ranks are calculated for each parameter ( $\bar{r}_{ij}$ ):

$$\bar{r}_{ij} = \frac{\sum_{i=1}^n r_{ij}}{m}; \quad (4)$$

- 8) the consistency of the experts' averaged opinions is checked using the formula:

$$W = \frac{12S}{u^2 (n^3 - n)}, \quad (5)$$

where  $W$  is the concordance coefficient for the averaged expert opinions;

$S$  is the sum of deviations squares of ranks' sums for averaged expert opinions, determined by the formula:

$$S = \sum_{i=1}^u (\bar{r}_{g_{ij}} - \bar{r}_{ij})^2; \quad (6)$$

- 9) a verification of the significance of  $W$  is carried out using the criterion  $\chi^2$ , while for the averaged expert estimates the calculation is the following:

$$\chi_E^2 = \frac{12S}{u (n^2 + n)}; \quad (7)$$

Similarly, if  $\chi_E^2 > \chi_{CR}^2$ , then  $W$  is recognized as significant, and the averaged expert opinions are consistent;

- 10) with the consistency of the experts' averaged opinions, the most important parameters of financial instruments are selected according to the following algorithm:

- a) if  $\bar{r}_{ij} \geq \frac{v}{n}$ , then the parameter of the financial instrument is considered significant;
- b) if  $\bar{r}_{ij} < \frac{v}{n}$ , then the parameter of the financial instrument is recognized as insignificant.

At the *fourth stage* of the algorithm, specific weights (shares) of the selected parameters of the M&A financial instruments are determined. The specific weight of the parameter of the financial instrument determined by the limiting factor ( $f_{x_{LF_i}}$ ) is calculated as:

$$f_{x_{LF_i}} = k_{IM} \cdot f_{x_{F_i}}, \quad (8)$$

where  $k_{IM}$  is the coefficient of the financial instrument parameter's importance, expertly determined by the transaction parties, with  $k_{IM_{\min}} = 1$ ;

$f_{x_{F_i}}$  is the specific weight of the financial instrument parameter not determined by the limiting factor, where  $f_{x_{F_1}} = f_{x_{F_2}} = \dots = f_{x_{F_n}}$  defined as:

$$f_{x_{F_i}} = \frac{1}{n - 1 + K_{IM}}. \quad (9)$$

To ensure the representativeness of the results, it is assumed that the maximum value of  $f_{x_{LF_i}}$  can not exceed 0.50 (or 50.00%).

At the *fifth stage* "preferable" values of financial instruments parameters are identified. At this stage, there is a formation of a holistic view of the financial instruments parameters

that are “ideally suited” to the terms of a particular M&A transaction, and, accordingly, the expert definition of the “preferred” parameters of financial instruments ( $x_{P_i}$ ).

At the sixth stage the “preferred” financial instruments parameters are compared with their actual or potentially possible parameters. The comparison is carried out in two stages: at the first stage, the “preferred” financial instruments parameters are compared with the parameters of the instruments that are already available to the company, and at the second stage – with the parameters of financial instruments that the company can potentially use.

To ensure the correctness of the comparison, an approach is used that focuses on recording only negative deviations in the financial instruments parameters and assumes the following calculation logic:

- 1) calculating the absolute deviation of the actual or potentially possible value of the financial instruments parameter from its “preferred” value, taken modulo ( $|\Delta|_i$ ):

$$|\Delta|_i = x_{F_i} - x_{P_i}; \quad (10)$$

- 2) determining the nature of the arising deviations:
  - when there are “positive” deviations  $|\Delta|_i$  is accepted equal 0;
  - when there are “negative” deviations  $|\Delta|_i$  is accepted equal to its actual value;
- 3) calculating the relative deviation value ( $d_{x_{F_i}}$ ):

$$d_{x_{F_i}} = \frac{|\Delta|_i}{x_{P_i}} \cdot 100\%, \quad (11)$$

- 4) determining the degree of financial instrument’s compliance to the M&A transaction participants’ expectations by all parameters ( $DC_{F_i}$ ):

$$DC_{F_i} = 100\% - \left( \sum_{i=1}^n d_{x_{F_i}} \cdot f_{x_{F_i}} \right). \quad (12)$$

The described procedure for determining the degree of compliance of a financial instrument with the expectations of the transaction participants should be consistently performed with respect to each financial instrument. The financial instrument which parameters completely correspond to the transaction participants’ expectations or exceed them, is recognized as a benchmark, and has a degree of compliance ( $DC_{F_i}$ ) equal to 100%.

At the seventh stage the instruments for financing the M&A transaction are being chosen. Based on the calculated indicator  $DC_{F_i}$  a consistent ranking of all financing instruments is made. The ranking of financial instruments is carried out from the highest to the lowest value of the indicator of the degree of compliance of the financial instrument to the expectations of the M&A transaction participants. Participants in the transaction expertly set the minimum allowable value  $DC_{F_i}$ , at which the financial instrument is recognized as not corresponding to the preferred parameters of the transaction.

### III. APPLICATION

Approbation of the developed complex algorithm for the selection of instruments for financing M&A transactions is done using the example of JSC “Agrofirma Volga”, acting as a buyer company, and JSC “Zorinskoye”, acting as a target company. JSC “Agrofirma Volga” is a company specializing in the production of agricultural products. The company operates mainly in crop and livestock production. Crop production is a key area of business of JSC “Agrofirma Volga”, therefore the company intends to increase the cultivated land bank and is interested in purchasing large land areas (from 5000 hectares and more) located relatively close to the existing production capacities of the company. Acquisition of a company specializing in agricultural production is being considered as one of the options for increasing the cultivated land bank.

JSC “Zorinskoye” is a company specializing in the crop production. Due to the significant volume of the land bank, the company is of interest to JSC “Agrofirma Volga” as a potential target for acquisitions. Negotiations between representatives of JSC “Agrofirma Volga” and JSC “Zorinskoye” started on January 10, 2018. The parties considered the option of acquiring JSC “Zorinskoye” by purchasing 100% of the company’s shares; and the company was supposed to be managed by the new owner’s representatives after the change of the controlling shareholder.

In accordance with the developed algorithm for the selection of instruments for financing M&A transactions, the time factor ( $L_T$ ) is the limiting factor for this particular transaction. The value of JSC “Zorinskoye” (adjusting for the existing debt) was agreed by the transaction’s parties on January 30, 2018 and amounted to 36 million rubles (settlement tranche – until March 31, 2018), with the buyer company undertaking to pay an additional 12 million rubles if JSC “Zorinskoye” would be profitable by the end of 2018 (settlement tranche – until June 30, 2019) hence,  $t_{n_i} = 2$ .

At the next stage of the financing instruments selection, two expert groups were formed with 4 experts in each (one group by the buyer company and the other by the seller company), which together picked out 8 “crossing” parameters. According to the procedure described above, which involves the use of the Kendall concordance coefficient and verification of its significance, the following were selected out of the 8 “crossing” parameters:

- 1) time for accumulating financial resources (parameter due to the limiting factor) ( $LF_1$ );
- 2) volume of accumulated financial resources ( $F_2$ );
- 3) cost of financial resources ( $F_3$ );
- 4) requirement for providing collateral security and/or surety to get financial resources ( $F_4$ ).

These parameters are the same for both stages of the transaction. With  $k_{IM} = 2$  determined by the transaction parties, the distribution of the weights for the chosen parameters are presented Table I.

“Preferred” values of the financial instruments’ parameters are determined for each of the stages and presented in Table II.

**TABLE I**

SPECIFIC WEIGHTS OF THE PARAMETERS OF FINANCIAL INSTRUMENTS

Parameter	Specific weight of the parameter, %
$x_{LF_1}$ , days	40.00
$x_{F_2}$ , million rubles	20.0
$x_{F_3}$ , % per annum	20.00
$x_{F_4}$ , million rubles	20.00
Total	100.00

**TABLE II**

"PREFERRED" VALUES OF THE FINANCIAL INSTRUMENTS' PARAMETERS FOR SETTLEMENT TRANCHES OF A POTENTIAL M&amp;A TRANSACTION

Parameter	First settlement tranches	Second settlement tranches
$x_{LF_1}$ , days	60	516
$x_{F_2}$ , million rubles	36.0	12.0
$x_{F_3}$ , % per annum	15.0	15.00
$x_{F_4}$ , million rubles	5.0	3.0

**TABLE III**

COMPARISON OF THE FINANCING INSTRUMENTS ACTUALLY AVAILABLE TO JSC "AGROFIRM VOLGA" FOR THE ACQUISITION OF JSC "ZORINSKOYE"

Parameter	Cash provided by JSC "Rosselkhozbank"	Cash funds provided by JSC "Nizhnevolzhsky Commercial Bank"
Time	0%	0%
Amount	-1700%	-1544%
Cost	0%	0%
Security	0%	0%
$DC_{F_i}$	83.00%	84.56%

**TABLE IV**

COMPARISON OF THE FINANCING INSTRUMENTS POTENTIALLY AVAILABLE TO JSC "AGROFIRM VOLGA" FOR THE ACQUISITION OF JSC "ZORINSKOYE"

Parameter	Cash provided by JSC "Rosselkhozbank"	Cash funds provided by JSC "Nizhnevolzhsky Commercial Bank"	Cash provided by PJSC "Sberbank of Russia"	Shares of JSC "Agrofirma Volga"	The bonds of JSC "Agrofirma Volga"
Time	-3333%	0%	0%	-4000%	-4000%
Amount	-611%	-1833%	-1446%	0%	0%
Cost	-133%	0%	0%	-533%	-267%
Security	0%	-400%	0%	0%	0%
$DC_{F_i}$	5923%	7767%	8554%	5467%	5733%

During the preparation for the transaction, JSC "Agrofirma Volga" had the following valid credit lines:

- 5.4 million rubles. at a rate of 14.0% per annum in JSC "Rosselkhozbank";
- 8.2 million rubles. at a rate of 15.0% per annum in JSC "Nizhnevolzhsky Commercial Bank".

Potentially, JSC "Agrofirma Volga" could use the following financial instruments:

1) cash:

- JSC "Rosselkhozbank" is ready to increase its credit limit by 25.0 million rubles at a rate of 16.0% per annum, but only after the official annual financial statements for 2017 become available, i.e. given the time required for the statements' approval – not earlier than May 20, 2018;
- JSC "Nizhnevolzhsky Commercial Bank" is ready to increase the existing credit limit by 3.0 million rubles, subject to security provision for 6.0 million rubles, the interest rate is 15.0% per annum, the time for approval is not later than March 20 2018;
- PJSC "Sberbank of Russia" is ready to open a credit limit of 10.0 million rubles without providing security at a rate of 14.5% per annum before February 28, 2018;

2) shares:

- JSC "Agrofirma Volga" is considering the possibility of issuing additional shares for 50 million rubles; the cost of the company's equity capital is 19.0% per annum, and the consultants of PJSC "Bank VTB" suggest the financial resources can be obtained no later than September 15 2018;

3) bonds:

- JSC "Agrofirma Volga" is ready to place an additional issue of bonds of 50 million rubles, and consultants of PJSC "Bank VTB" assess the cost of obtaining financial resources no less than 17.0% per annum, and the time for obtaining – no later than June 18, 2018 (the results of a comparison of all the above financing instruments are presented in Tables III and IV).

The minimum level for this transaction  $DC_{F_i}$  is 80.00%, i.e. among all actually and potentially available financing instruments, JSC "Agrofirma Volga" can use only cash (Table V).

Thus, the considered financial instruments do not allow JSC "Agrofirma Volga" to finance the first stage of the transaction with JSC "Zorinskoye": in the required time period the buyer company can obtain only 23.6 million rubles (out of the

TABLE V  
THE LIST OF FINANCING INSTRUMENTS AVAILABLE TO JSC “AGROFIRM VOLGA” FOR THE ACQUISITION OF JSC “ZORINSKOYE”

Financing instrument	$DC_{F_i}, \%$
Cash provided by PJSC “Sberbank of Russia”	8554
Cash funds provided by JSC “Nizhnevolzhsky Commercial Bank”	8456
Cash provided by JSC “Rosselkhozbank”	83.0

required 36.0 million rubles). Hence, given the chosen parameters values, this M&A transaction can not be completed.

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