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Models for Creating Price Politics of a Company Entering the Market for Speech Analytics Technologies

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ABSTRACT

The article is devoted to adapting general mathematical models of the software markets for describing the market of the specific product. These are the technologies of artificial intelligence in speech analytics. The **purpose** of this study is to create a modeling instrumentation for pricing the technologies of speech analytics in companies which enter this market. The purpose also includes recommendations provided with the price politics. The object of the study is the Russian market of speech analytics technologies. The subject of the study are the prices of this product in companies which enter the market being explored. In this studying the authors use classical **methods** of economical and mathematical modeling the markets with different competitive levels (monopoly, duopoly, oligopoly, monopolistic competition). The **results** of the study are the foundations of prices for the companies which enter the speech analytics market. These prices are based on three kinds of economical mathematical models: regression, rating and marginal indicators. All three kinds of models lead to one recommendation. A company which enters the speech analytics market should establish the prices with less orientation to the indictors of analytics' quality. Because in all three models this factor has very weak influence on a result. More important factor are the additional options. Their bigger quantity allows a company to establish a price which is nearer to the same one of the market leaders.

Keywords: artificial intellect; speech analytics technologies; software market; pricing; level of monopolization

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INTRODUCTION

Technologies based on artificial intelligence are currently a central component of all transformational processes in the business of both financial and real production profiles [1, 2, 3]. There are already many research results dedicated specifically to the application process of such technologies. However, the processes of the movement of these technologies as a market product from buyer to seller remain unexplored in the literature. The main quantitative characteristic of any such process is price. This paper presents the results of a study aimed at forming the primary principles of scientifically grounded pricing in the artificial intelligence technology market, using the example of a group that implements speech recognition and speech analytics functions.

The market for speech analytics technologies is developing quite intensively in Russia, which is generally happening within the framework of the currently established trend towards the rapid development of the information and communication infrastructure of the digital economy, increasing its integrity, and a strong focus on the deep qualitative transformation of all business processes [4, 5].

At the same time, the development of the speech analytics technology market is characterized by contradictory trends. On the one hand, in terms of the absolute number of participants, it can be considered highly competitive, as this number currently exceeds 100.[1] But on the other hand, a more detailed immersion into the state of affairs in this market in modern Russia provides an understanding that resources and opportunities among its participants are distributed extremely unevenly: the majority have been "pulled" by no more than five of the largest market players, while almost 100 others share a very small portion of it among themselves. From this, it follows that nothing prevents any new player from starting to capture a certain share of this market, but their actions must be very carefully thought out and scientifically justified to fit into this system, taking into account the already established distribution of roles between its largest players and a large mass of smaller ones. The relevance of this issue for firms striving to become participants in the modern Russian market of speech analytics technologies has determined the goal, objectives, and structure of this study.

The purpose is to develop a pricing recommendation system for speech analytics products for organizations currently entering this market in Russia. Within this purpose, the following tasks have been set:

1. Justify the choice of pricing methods for the considered type of products among the array of similar methods applied to products related to software, innovative, and intellectual products, information about which is available in specialized and scientific literature;

2. Evaluate the current state of prices for speech analytics technologies in the Russian market;

3. Consider an example of using selected pricing methods for an organization entering the market in question, taking into account the existing prices on it.

The paper consists of a description of the methods and materials used during the research, its results in the context of each of the previously set tasks, and the conclusions drawn from the obtained results.

METHODS

During the research, methods developed by three major domestic scientific schools in the field of mathematical modeling of market pricing processes in the context of the formation and development of an innovative, information-knowledge economy were applied: Lomonosov Moscow State University,

[1] Analysis of the speech technology and speech recognition market in Russia. 2021. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

the Central Economic and Mathematical Institute of the Russian Academy of Sciences, and the Financial University under the Government of the Russian Federation. The information base of the research consisted of data from the official websites of companies that are currently major players in the domestic speech technology market, reports on the financial and economic condition of these companies obtained from the "SPARK-Interfax" information system, and analytical reviews from business portals on the state of affairs in the domestic speech analytics technology market.

RESULTS

Result 1

The current developments in domestic scientific literature in the field of pricing for products in the area of software, information, and intellectual technologies have been analyzed. The analysis led to the following conclusions.

Overall, the issue of pricing for software products in general, and artificial intelligence in particular, cannot be considered sufficiently developed to meet the existing needs of the practicing business community in this field. To be more precise, there are currently no pricing methods specifically designed for artificial intelligence technologies (including those used in speech analytics) in the specialized literature. If we take a broader view — considering software products as a whole — then even here, the number of scientific and practical developments cannot be considered commensurate with the intensity at which this market is currently evolving. We can identify only three research directions in this field that have developed over the past 15 years in three educational and scientific organizations.

At the Central Economic and Mathematical Institute of the Russian Academy of Sciences, V.E. Dementyev and E.V. Ustyuzhanina, along with co-authors, are developing a system of pricing methods for markets of innovative and software products under conditions of high levels of imperfect competition (monopoly, monopsony, duopoly, oligopoly) [6–10]. However, the question of the applicability of the findings from these studies to our issues remains a topic of discussion. Because it is not entirely clear whether the market for speech analytics technologies in Russia can currently be considered a market with a high degree of oligopolization. It seems possible to use models developed in the works of the Central Economics and Mathematics Institute of the Russian Academy of Sciences to describe the behavior of a firm entering the speech analytics market, if we consider the set of already existing firms as a conditional "generalized first duopolist", and the firm in question as a new duopolist challenging it, but careful elaboration of the parameters of such an economic-mathematical model is required.

A fairly extensive study on the issues of software pricing was conducted in the doctoral dissertation of V.I. Soloviev (Financial University) from 2010 [11] and in his subsequent publications, where this research is further developed [12, 13]. However, his practical findings are only oriented towards cases where the firm is introducing a completely new software product to the market, and therefore, the firm's behavior regarding this type of product is modeled as purely monopolistic. For an average company operating in the Russian speech analytics technology market, this approach is generally not applicable, but it should be considered as a potential option in case any participant in the market creates a completely new and unique product and starts promoting it.

During the same period, a comprehensive study on this issue was conducted in the doctoral dissertation and related publications of O.N. Antipina (Moscow State University), which, unlike the two previously described, is oriented towards a more universal picture of the market regardless of the degree of its monopolization. Among the results of this study, the systematization of normative-parametric pricing methods, viewed through

the lens of the peculiarities of the software market (in this paper, they are considered using antivirus software as an example), deserves particular attention. Three methods are identified: specific indicators, regression, and scoring [14–17].

In this paper, these three methods are chosen as the basis for pricing recommendations in the speech analytics technology market. This is because they are characterized, on the one hand, by ease of application, and on the other, by the ability to encompass the entire array of available information about the current pricing situation in the market under consideration.

Result 2

The data on the current state of affairs in the field of pricing for speech analytics technologies in Russia has been systematized. In general, it should be noted that the search for empirical information related to the issue under study, as well as the search for theoretical literary works on it, represents a very complex task.

At the initial stage of the research, a direct search for information on prices offered by major market players on their official websites was conducted. However, a problem was discovered: most of the companies reviewed do not provide detailed explanations of their pricing policies in open access on the internet, instead offering potential clients to get in direct contact to discuss pricing issues on an individual basis. When modeling the purchase situation using the "mystery shopper" method, researchers faced a lack of input data to build a simulation model of an individual typical business representative — a potential system buyer.

Next, an attempt was made to determine the prices of the products of these same companies indirectly, by dividing their annual revenue in rubles by the volume of information in bytes processed according to customer orders during the same period. The calculations of this kind were proposed to be based on data from the largest database in Russia today on the financial and economic condition of legal entities and individual entrepreneurs — SPARK-Interfax. However, the analysis of the business condition reports of the nine companies[2] under consideration obtained from this system also did not yield any significant positive results. It turned out that among the companies reviewed, only the group of companies Speech Technology Center (STC) has all the quantitative data necessary for calculations according to the proposed algorithm — i.e., revenue volumes and processed client traffic information. Among the other eight companies, there is no data on processed client traffic information from previous years at all, and for some of them, there is not even data on financial performance from previous years (which is why, according to its rules, the SPARK system itself has marked these companies with "Suspicious Activity" due to very small turnover volumes according to official reports). The obtained results are due to the historically established features of how Russian business structures provide official reporting to the Federal Tax Service and other authorized bodies (and the SPARK system accumulates information exclusively from such documents). Among the companies examined, only STC is a large business structure. Moreover, it is related to Sberbank of Russia through subsidiary relationships, which is why only its official reporting across all areas of activity is complete and detailed. The other eight firms in the examined sample do not provide their official documentation with the transparency that would allow for a complete picture of their financial and economic condition, including in terms of product pricing.

As a result, the only available and sufficiently informative source of data on the existing pricing practices in the speech

[2] Information and Reference System SPARK-Interfax. 2023. URL: https://spark-interfax.ru/ (accessed on 28.03.2023).

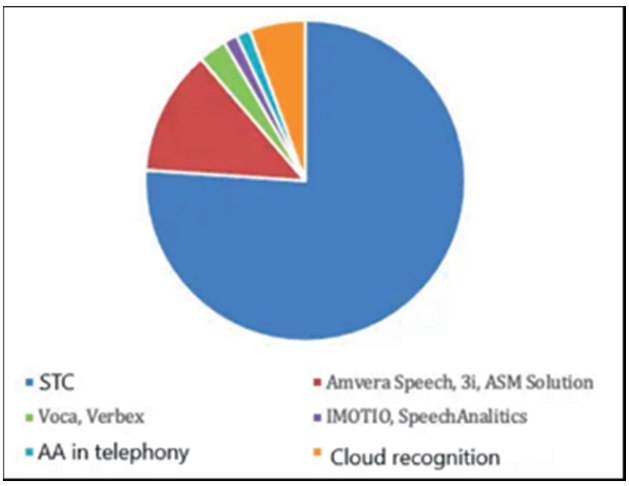

Fig. **Distribution of Incomes between the Leaders of Russian Speech Analytics Market in 2020**

Source: VC net edition. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

analytics market in Russia turned out to be specialized analytical reports available online. The analysis of websites with such reports led to the selection of four of them as the basis for further research (all other websites, as the content analysis showed, ultimately use data from these same four resources). Among the selected internet resources, the most comprehensive is the report by the online publication *VC*,[3] which is used as the primary source in the study. For additional verification of the results, the study uses data from reports prepared by the information portals *Sales of Artificial Intellect (SalesAI),*[4] *Just Artificial Intellect (Just-AI)*[5] and *It-World.*[6]

First and foremost, the report by the online publication *VC* contains a diagram that provides a complete overview of the power distribution in the domestic speech analytics technology market at present (*Fig.*). The power distribution is presented in the format of company shares in the total revenue earned by this sector in 2020.

The diagram shows that the undisputed market leader is the previously mentioned subsidiary of Sberbank — STC, which accounted for ¾ of the revenue earned in the sector as a whole in 2020. This is consistent with data from another report presented on the *Just-AI* portal,[7] according to which the total revenue in the sector under consideration in 2020 amounted to 3.2 billion rubles, of which 2.7 billion rubles were attributed to STC. In second place on the chart is the share of the company Amvera, and in third place is the cloud technologies from Yandex Cloud. Thus, the presented diagram provides an initial overview of the current top three leaders in the market under consideration.

Next, this choice is confirmed by the analysis of the technical specifications of the products from the companies presented in the *VC* report. The most significant among them is the word error rate (WER), which is the proportion of incorrectly recognized words in their total volume processed over a certain period. This indicator is better the lower it is (*Table 1*). The indicator is calculated separately for analyzing speech over a telephone line and recorded on an audio badge (i.e., noisy speech).

The calculated error percentages are converted into scores from 1 to 5, where a score of 5 is awarded to the company with the lowest error percentage for each type of speech, and a score of 1 to the company with the highest error percentage. As a result, for telephone speech recognition, the highest score is awarded to Yandex, and the lowest

[3] Analysis of the speech technology and speech recognition market in Russia. 2021. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

[4] Analysis of the Russian Speech Analytics Market. 2022. URL: https://blog.salesai.ru/russian-market-of-ci (accessed on 28.03.2023).

[5] The conversational AI market in Russia 2020–2025. Analytics, forecast. Trends. Research Just AI. 2021. URL: https://just-ai.com/wp-content/uploads/2021/08/russianmarket2021-justai.pdf (accessed on 28.03.2023).

[6] Speech analytics services for business: pros and cons. 2022. URL: https://www.it-world.ru/tech/choice/185140.html (accessed on 28.03.2023).

[7] The market for conversational AI in Russia 2020–2025. The conversational AI market in Russia 2020–2025. Analytics, forecast. Trends. Research Just AI. URL: https://just-ai.com/wp-content/uploads/2021/08/russianmarket2021-justai.pdf (accessed on 28.03.2023).

Table 1

WER Indicators for the Results of Using Speech Analytics Technologies of 5 Market Leaders, %

Company	Yandex	Tinkoff	STC	Google	Amvera Speech
WER for telephone speech	19	22	27	32	24
WER for noisy speech	73	80	56	80	38

Source: Compiled by the authors according to VC. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

Table 2

Comparing the Technical Characteristics for the Speech Analytics Products of 5 Market Leaders

Company	Yandex	Tinkoff	STC	Google	Amvera Speech
Cloud version	Yes	Yes	Yes	Yes	Yes
The possibility of installation in the circuit	Yes	No	Yes	No	Yes
The ability to adapt the system to the acoustics and linguistics of a specific task	No	No	Yes	No	Yes
The possibility of working on the CPU	No	No	Yes	No	Yes
The possibility of working on a GPU	Yes	Yes	No	No	No

Source: Compiled by the authors according to VC. URL: https://vc.ru/trade/640019-analiz-rynka-rechevyh-tehnologiy-i-raspoznavaniya-rechi-v-rossii (accessed on 28.03.2023).

to Google. For the quality of recognizing noisy speech, Amvera receives the highest score of 5 points, while Tinkoff and Google receive 1 point each. The scores received by the companies for the quality of recognition of both types of speech are summed up, and their final ranking looks as follows:

- Yandex — 8 points;
- Amvera — 8 points;
- STC — 6 points;
- Tinkoff — 5 points;
- Google — 2 points.

The WER indicator is the main one, but not the only one; in addition to it, the five companies considered in the *VC* report are compared based on five other technical characteristics (*Table 2*).

The result is close to the final analysis of the WER indicators. Here, the leaders are CRT and Amvera, who have four out of five indicators in the "green zone", with Yandex slightly trailing behind with three green indicators. That is, in the end, the top three leaders remain the same as with the WER indicator. And Google and Tinkoff once again end up as outsiders.

Thus, the conducted analysis of the technical characteristics of speech analytics products confirmed the previously formulated decision to use data on the three leading market players — STC, Amvera, and Yandex — as the basis for modeling in further research.

Here in the *VC* report, data is provided to calculate the average price of their services in

Table 3

Data for Calculating the Price of the Speech Analytics Product According to the Method of Regression

Company	Price (P), ₽	Word error rate (WER), score	Additional options (AO), score
Яндекс	0.60	8	3
STC	1.20	6	4
Amvera	1.25	8	4

Source: Compiled by the authors.

rubles per minute of recognized conversation time. For STC and Yandex, the report provides rates in rubles per stream; the authors of the report define a stream as 50 000 minutes of speech per month. For STC, the monthly price for the stream is 60 000 rubles, for Yandex it is half that, i.e., for the first company the price per minute is 1.2 rubles, for the second it is 0.6 rubles. A slightly more challenging task was calculating the cost of 1 minute for the Amvera. According to the *VC* report, clients of this company can use two payment options for services. When using the "in contour" version of the product, the client pays 1.9 million rubles per year for 12 streams per year, each stream, as mentioned earlier, is considered equal to 50 000 minutes. However, the company also "gifts" the client an additional 3 000 minutes each month and 300 minutes each day. Thus, for the aforementioned amount, the client receives a total number of minutes per year equal to 12 * 53,000 + 300 * * 365 = 769 500 minutes. Then the price per minute is 1900 / 769.5 = 2.47 rubles. When using the cloud version, the client pays 24,000 rubles per year, and then the price per minute is 24 / 769.5 = 0.03 rubles. If we assume that among the company's clients there are approximately equal numbers of users of the cloud and "contour" versions, then the average price of services at Amvera is equal to the arithmetic mean of the two obtained prices and amounts to 1.25 rubles per minute. The result seems plausible, as it is close to the corresponding indicator of the STC company, whose product has similar technical characteristics to those of Amvera's product from *Table 2*, and even surpasses it in terms of the WER indicator. Thus, the conclusion from the analysis of the pricing policies of the three leading market players is as follows:

- Yandex — 0.6 rubles/min.;
- STC — 1.2 rubles/min.;
- Amvera — 1.25 rubles/min.

These results, calculated based on the *VC* report data, are consistent with the data from the *SalesAI* and *It-World* reports, where such detailed indicators as in the VC report are not provided. But on the *SalesAI* portal, the standard range for the price of speech recognition services is given as 0.45 to 1.5 rubles/min, while on the *It-World* portal, the average value of such a price in the modern Russian market is indicated as 0.98 rubles/min. Thus, the calculated prices of the product under consideration for the three selected companies for analysis are taken as the basis for building mathematical pricing models, which are proposed for use by new firms entering this market.

Result 3

The third result essentially integrates the two previous ones. The methods chosen in obtaining result 1 are used to build prices based on the data obtained during the process of obtaining result 2.

Table 4

Data for Calculating the Price of a New Company's Product According to the Method of Rating if a Speech Analytics Product has 4 from 5 Additional Options

Company	Price (P), ₽	Word error rate (WER), score		Additional options (AO), score	
		Score	Weight	Score	Weight
Company base for comparison	1.22	7	0.5	4	0.5
New company	P	6	0.5	4	0.5

Source: Compiled by the authors.

Table 5

Data for Calculating the Price of a New Company's Product According to the Method of Rating if a Speech Analytics Product has 3 from 5 Additional Options

Company	Price (P), ₽	Word error rate (WER), score		Additional options (AO), score	
		Score	Weight	Score	Weight
Company base for comparison	0.6	8	0.5	3	0.5
New company	P	6	0.5	3	0.5

Source: Compiled by the authors.

The regression method consists of constructing an equation that establishes the dependence of the product price *P* on a number of factors, with the number of factors needing to be one less than the number of companies being considered. Because otherwise, the system of equations constructed to calculate the constant coefficients of the derived mathematical model will not have a solution. To achieve this, within the framework of the present study, the other options presented in *Table 2* are combined into a single factor, rated on a scale from 1 to 5, based on the number of indicators that each company falls into the green zone. Thus, STC and Amvera each receive 4 points for this indicator, while Yandex receives 3 points. The initial data for constructing the regression model is presented in *Table 3*.

Thus, the sought regression coefficients are found from the system of equations:

$$\begin{cases} 0.6 = a*8 + b*3 + c \\ 1.2 = a*6 + b*4 + c \\ 1.25 = a*8 + b*4 + c \end{cases}$$

We obtained a system of three equations with three unknowns (that's why the number of factors must be less than the number of companies considered) and using the MS Excel function "Data Analysis — Regression" we find the coefficients of the mathematical model:

$$P = 0.025 * WER + 0.65 * AO - 1.55.$$

The resulting model provides a basis for calculating the price of a similar product for a new company entering the market in question. Let's consider a hypothetical company whose recognition quality for both phone and noisy speech is rated at 3 points (the average of

Table 6

Data for Calculating the Price of a New Company's Product According to the Method of Marginal Indicators

Company	Price (P), ₽	Additional options (AO), score	Marginal price per 1 score
Yandex	0.60	3	0.20
STC	1.20	4	0.30
Amvera	1.25	4	0.31
Average unit price per point for additional options evaluation			0.27

Source: Compiled by the authors.

Table 7

Resulting Table of the Prices Accounted According to All the Three Methods

Method	New company's product has 4 of 5 additional options	New company's product has 3 of 5 additional options
Regression	1.20	0.55
Scoring	1.11	0.50
Specific indicators	1.10	0.80
Price averaged across all three methods	1.14	0.62

Source: Compiled by the authors.

possible options). Thus, in total, it has a WER score of 6 points. As for the other options, two scenarios should be considered here. In the first scenario, the new company can offer customers four out of five possible additional options, then it can set the price of its product at P = 0.025 * 6 + 0.65 * 4–1.55 = 1.2 rubles per minute. That is, it can afford to set a price at the level of market-leading companies, but it should be set at the lowest of the two possible leader price options, since the company is still new to the market. In the second scenario, if the company can offer clients only three out of five possible options, its price will be P = 0.025 * * 6 + 0.65 * 3–1.55 = 0.55 rubles per minute. That is, its price in this case should be lower than the lowest of the three considered during the model construction.

The scoring method, unlike the regression method, is based on the fact that the price of a product from a new company is evaluated based on not several, but only one basis for comparison. And here, just like in the case of regression, two scenarios for the company's product parameters should be considered. If the new company has a speech recognition quality level of 6 points and can offer customers four out of five possible additional options, then the conditional company, "averaged" from STC and Amvera, should be considered as its benchmark for comparison. The data for calculating the price of the new company using the point method in the first scenario is presented in *Table 4*.

In the case of the scoring method, unlike the regression method, the multipliers for scoring

factor evaluations are not coefficients calculated by special algorithms, but weights determined by a competent team of experts based on personal knowledge and experience. In this case, the expert group identified two factors as equally influencing the formation of the product price. The sought value — the price of the product from a new company entering the market — is calculated using the "cross" rule of proportion:

$$P = 1.22 * \frac{(6*0.5+4*0.5)}{(7*0.5+4*0.5)} = 1.11 \text{ rubles/min.}$$

In the second of the possible scenarios, the product of the new company is similar in characteristics to the analogous product of Yandex, and here it serves as a basis for comparison (*Table 5*).

The price of the product in this case:

$$P = 0.6 * \frac{(6*0.5+3*0.5)}{(8*0.5+3*0.5)} = 0.5 \text{ rubles / min.}$$

The method of specific indicators is similar to the regression method in that it takes into account data from all other companies included in the analysis, but only one factor, evaluated in points, is considered in the calculations. In this study, the factor of additional options was chosen, as calculations based on the previous two methods showed that it contributes more significantly to the differences in pricing under various product operation scenarios in the new company. The calculations using this method are presented in *Table 6*.

Let's also consider two options for additional features of the product from the new company entering the market. If it offers its clients four out of five additional features, its price will be 4*0.27 = 1.10 rubles per minute of recognizable speech. With three out of five features available, the price will be 3*0.27 = 0.80 rubles per minute.

The results of the calculations using all three methods under both possible scenarios are summarized in *Table 7*. The last row of the table shows the average price for each option of having additional features in the developed software product.

CONCLUSION

The presented calculations form the basis of recommendations regarding the price range for speech analytics technology for an organization entering this market in Russia at the current time. Further research directions are planned to be linked to the following issues:

1. Consider pricing options for a specific company with precisely measured WER values for telephone and noisy speech.
2. Consider the possibility of modeling the price of speech analytics technology for a company entering the market, if the other companies are considered as a single hypothetical duopolist according to the methodology of V. E. Dementyev and E.V. Ustyuzhanina,
3. Consider models for pricing speech analytics technologies with unique properties, such that the company implementing such a product can be regarded as a monopolist.

At this stage of the research work, the tasks set have been solved, and the goal has been achieved.

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