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Providing Innovative Processes in the Economic Development of the Russian Regions

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Abstract

One of the most important demonstrations of the modern economy is the growing importance of innovation. The innovative process or the process of technological change is a complex concept encompassing the improvement of products, production processes, raw materials as well as management methods. Therefore, the central aim of the research is to analyse the innovative processes that contribute to the development of the state economy. To accomplish the objectives, we carried out the calculations to examine the relations between the cost indicators, modelling, correlation and regression analyses. The particularities of business processes in innovative activities of organisations lead to uneven distribution, specific cost structure in the crisis and the traditional situation of an insignificant share of innovation in the financing process. The study presents a mathematic model of innovation activities of an enterprise, based on economic indicators of current operations. The object of the research is industrial enterprises. Since an important segment of business processes in innovation is small innovative companies, our task is to develop a methodology for forecasting the number that would be suitable for them. From the findings of our research, we concluded that the models that had been previously developed were more effective at the micro-level. Based on the analysis of the distribution of costs between technological, marketing, organisational innovations by types of innovation and economic activities by building an adequate set of statistical models, we have identified the following particularities: the basic internal (directly dependent) and external (indirectly affecting) factors that affect the selected performance characteristics.

Keywords: Development, Innovation, Structure, Enterprise, Economy, the Republic of Tatarstan

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Introduction

Business processes go through a cycle of transition. Usually, it is a smooth transition from traditional to innovative business processes, and, on the contrary, from innovative to traditional process due to time influence. It follows that the process is cyclical in time and space. The ratio of innovative and traditional business processes in industrial enterprises can be represented as 2/3: 1/3 due to the progressive development of these organisations. This ratio acts as a catalyst for the economic development of organisations (Karlik, 2013).

The mechanisms consist of innovative business processes, traditional business processes, funds, funds of funds, financial markets, methods of implementation, levers of impact, informational and normative-legal support of individual and public interests (Tucker, 2008; Watts, 1995). As a rule, the development of innovation is characterised by high complexity and requires different views and public recognition. Consequently, the term "innovation" includes new technological, economic, organisational and social solutions which are not necessarily economically relevant with direct monetary dependence but are applicable and used. Therefore, knowledge and ideas are the most critical components of innovation (Juran, 1994; Howlett, 2018).

The innovative product can be considered from two sides: internal where there is a dependence on knowledge, capabilities, resources and technology used as well as external where the interest is focused on the consumer needs and user expectations (Trist & Bamforth, 1951). Taking into account the above factors, we can make the following assumption: the effectiveness and efficiency of the entire company depend on the effectiveness and efficiency of the business processes of the company (Mishchenko, 2009; Mishchenko & Mishchenko, 2015; Mishchenko & Mishchenko, 2016; Mishchenko et al., 2016). This, in its turn, is the achievement of targets that are determined by the requirements of subsequent business processes (Silagadze, 2017; Silagadze, 2018; Atanelishvili & Silagadze, 2018). The achievement of excellent efficiency of business processes in the innovation environment is a tool for improving the competitiveness of the organisation due to the quality increase of all processes and cost reduction (Kolesnikov et al., 2018; Usenko et al., 2018). In light of these arguments, the key objectives of this research are as follows:

- to reveal the particularities of business process modelling;
- to reveal the factors that are important in the methodology of correlation and regression analysis;
- to choose a linear model based on the importance of regression coefficients, significance of the equations as a whole and coefficient of correlation and autocorrelation of remainings;
- to develop an economic-mathematical model of the factors of innovative-active organisations activities; economic-mathematical model of the network of innovative-active organisations based on the resource centre.

The research begins with a brief review of the literature. Following this, it discusses the materials and methods deployed. Moreover, the final sections discuss the findings of the research.

Literature Review

Business process management continues to be a top priority in business, and the separation of business processes remains a significant challenge for managers (Morozov, 2018; Laurinavičius, 2018; Boltochko, 2018; Jablonskis et al., 2018). This increases the interest in business process management, including scientific and commercial interest, aimed at expanding business solutions for process management. One of the bright and popular examples in this context is business process modelling. Business process modelling is a graphical approach that is present in business activities and includes activities, stakeholder flow management and their relations (Narvekar

& Jain, 2006). Due to the increased interest in a systematic approach to business process management, many organisations spend significant investment in process modelling, which, in its turn, implement significant research (Grishin, 2019). For example, the Sarbanes-Oxley Act has contributed to the increase of interest in business process modelling as a way of documenting the organisational processes.

The increasing interest in business process modelling and management has led to the creation of a wide range of modelling methods – from simple flowchart methods to methods originally used as a part of software development (such as UML), to highlighting business-oriented modelling approaches (such as event-driven process chains), to formalised and learned methods such as Petri nets and their description languages (Petri, 1962: 386-390). Consequently, a wide range of methods and tools for process modelling is offered in the competitive market. Significant demand for funds was created to evaluate and compare available methods (Scheer, 2000).

Given the interest in the modelling process as a way to cover all the processes of organisations in different areas, and given the many available methods to solve this problem, our interest is to explore different methods of modelling business processes to facilitate the modelling of real-world processes (Burov, 2019). Currently, there is a variety of approaches to the definition of the term "business process" (Kline & Rosenberg, 1986). M. Howlett defines a business process as an organised set of actions included in the activities of the organisation to create a result of value to the client (Howlett, 2018). John Champi characterises a business process as a set of actions that require one or more types of resources and create a result or effect that is of particular value to the buyer (Khamzina, 2017). In these definitions, the predominance of the marketing component in the characteristics of business processes is traced. However, the creation of consumer value directly affects such issues as the acquisition of value-added, the hierarchy of management relations, the specifics of the flows and resources of the organisation (Standard Flowchart Symbols and their Use in Information Processing, 1970).

Harrison says that the business process consists of procedures, steps, technology and the people needed for conducting essential operations within the company. As a rule, the process intersects with many organisational boundaries within the production activity and requires adjustment of these boundaries. In the definition of Harrison, there dominates the emphasis in the understanding of the organisation as a closed system since the emphasis is only on the "operations within the company (Baboshkina, 2018)." However, in the modern economy of the organisation, it is open systems and reorganisation of business processes of companies that should be focused on the ultimate goal and tied to specific target segments. The noted limitation in the interpretation of the concept of "business process" is overcome in the works of Evstratova and Buribayev (Evstratova et al., 2016; Buribayev et al., 2016). Shorts that indicate that a business process is a mixture of logically related tasks whose purpose is to achieve business results (Juran, 1994). They add that the process has two essential properties(Juran, 1994). The first process includes a buyer; the second business process goes beyond the organisational structures and does not depend on the formal organisational structure of the organization (Apakhayev et al., 2017).

The definition of business processes of the company is slightly expanded by the introduction of the critical restriction of reengineering of business processes of financial resources which we consider justified because, in the conditions of limited rationality, asymmetry of information, high speed of technological and market changes, the financial support of organisational changes is one of the key issues (VoLodzkienė, 2018; Abikenov et al., 2019). This is a prerequisite for achieving the primary goal of the company, which is to make a profit (Koshkin, 2018). The company carries out its economic activities in the company with constant, inevitable repetition in proportion to the working functions, which is the essence of the business process that is called the reproduction process in the company (Abikenov et al., 2019). In the production company, the latter consists of three phases: purchase of all business elements, production and sale (Ibraev et al., 2017). In the market economy, it is impossible to perform all three phases of a business process if these partial processes are not constantly funded (Ibraev et al., 2017). Thus, the financing process is also an integral part of the company's process indicators (Nielsen & Main, 2004).

Business processes are interrelated, consistent, structured outside the functional activities of the organisation with clearly defined start and end points as well as entry and exit (Abramov, 2018). However, the ultimate goal of these transformations remains beyond the vision of scientists and limited only by its phases (Atanelishvili & Silagadze, 2018).

S. V. Rubtsov believes that a business process is a unit of logically related procedures for the implementation and control of a planned product or service. The efficiency of the process can be determined and evaluated as a result of the consumption of resources used to convert the input to the output (Rothwell, 1994).

Thus, foreign and some Russian specialists use in their work the concept of "business process" to a greater extent as a business process (Kolesnikov et al., 2018). Moreover, in their works, they share the concept of "business" and "process"(Karlik, 2013). The second word is used only to separate the processes that are related to the creation of the economic value of the final product (service) from all other processes which operate in the organisation (Howlett, 2013). Any business process can be considered as a system of the interrelated business task, the solution of which is a specific sequence that leads to the output product. The set of tasks of business processes should satisfy the property of completeness, normalisation and connectivity (Narvekar & Jain, 2006).

One has to note, however, that there is no subject (change manager) in the definitions. Nonetheless, we further define the owner of the business process as the Central Administration that has the resources necessary for the implementation of the business process, who is finally responsible for the final product of the process. It is indicated that the process owner manages the process and is an integral part of the process (Khamzin et al., 2015; Buribayev et al., 2016; Apakhayev et al., 2017; Ibraev et al., 2017; Mukhamadiyeva et al., 2017a; Mukhamadiyeva et al., 2017b; Zhetpisbayev et al., 2017; Bidaishiyeva et al., 2018; Abikenov et al., 2019). Thus, we animate the subject of management, which is included in the set of activities (functions) (Khorin, 2018). In our view, this statement is confusing to some extent. It follows that our manager is identical to a certain technologically fixed management function, which in, its turn, is not so (Kline & Rosenberg, 1986). In turn, we attempt to classify the processes which link them to the organisational structure of the organisation. In our opinion, the way business processes should be organised already determined by those who should implement them (organisational units and divisions) (Abramov, 2016).

Materials and Methods

The theoretical and methodological basis of the research work is the theory of innovation, the theory of organisation management, the theory of innovative development modelling, the theory of process management and related concepts of business processes as well as reengineering. An essential role in understanding the theme of the research was played by modern methods of forecasting economic phenomena and processes and current models of state regulation of the economy (Abramov, 2017).

Models of business processes of separate types of innovation (technological, marketing, product and process innovation) on the basis of two modern methods of business process modeling (the DCOR process model allowing to conduct a joint evaluation of efficiency in a chain of development and introduction of innovation are formed; in notations IDEF0 (Integrated DEFinition) and IDEF3 increasing efficiency of decision-making along with known models of a quantitative evaluation of efficiency of innovation). The research is based on the application of a set of scientific methods, laws, economic and mathematical analysis, modelling and static and comparative analysis. The interdisciplinary approach takes into account the critical challenges faced by organisations and innovative managers in any economic system. The following sections critically discuss the findings of the research.

Results and Discussion

Modelling of innovation cost parameters is feasible by the methodology of correlation and regression analysis. First, we will select and analyse the factor particularities included in the multiple regression model. Second, we will check for the presence of multicollinearity.

To check the presence of multicollinearity between the dependent factorial particularities, pair correlation coefficients were calculated. Dependent variables are multicollinear if the pair correlation coefficient between them is greater than or equal to 0.75.

The following formula determines the pair correlation coefficient:

$$r = \frac{\overline{x \cdot y} - \bar{x} \cdot \bar{y}}{\sqrt{\overline{x^2} - \bar{x}^2} \cdot \sqrt{\overline{y^2} - \bar{y}^2}} \quad (1)$$

On Y_2 (number of innovative organisations) has a strong impact X_1 ($r_{y2x1/x2,x3,x4,x5,x6,x7,x8}$=0,873556723753235), moderate effect is X_2 ($r_{y2x2/x1,x3,x4,x5,x6,x7,x8}$=0,624706858109684), and the relations between X_1 and X_2 are weak ($r_{x1x2/y,x1,x2,x3,x5,x6,x7,x8}$ = 0,321554072722828). Therefore, as a pair of factors for the construction of multiple regression, we choose the process cost-pair X_1 X_2. X_1 – technological product costs of innovation in 2017; X_2 – technological process costs of innovation in 2017. Multiple regression differs from pair regression in the dependent random variable (the resulting variable) y effect at the same time n independent factor $x_1,x_2,...,x_n$ (Porter & Millar, 1985). The multiple regression equation looks like:

$$\tilde{y} = f(x_1, x_2, ..., x_n) \quad (2)$$

The correlation coefficient of the relations between y resulting indicator. The correlation coefficient of the ratio between the resulting indicator j -th ($j = \overline{1,n}$) x_j factor should be non-zero: $r_{yx_j} \neq 0$. When testing/hypothesis it should not be confirmed with P=0,9 probability. Factors $x_1,x_2,...,x_n$ must be pairwise independent.

Multiple regressions were constructed for variables: linear and nonlinear.

Multiple linear regression is the simplest form of multiple dependence. Its equation is written as:

$$\tilde{y} = b_0 + b_1x_1 + b_2x_2 + ... + b_nx_n \quad (3)$$

y is the resulting indicator (dependent variable), x_j $(j = \overline{1,n})$ – where the independent factor.

With the help of MS Excel analysis package, multiple linear regression for Y type was built: Y = 305,54+0,012X_1+ 0,001X_2. Coefficient b_0= 305,54 the constructed model is not significant, the coefficient of determination R^2= 0.98, this means that the correlation between Y_2 resulting indicator and X_1 and X_2 factors equals 0.98, and the average relative error of the approximation is 0.02. When checking the model for autocorrelation, DW=1.654 coefficient was obtained, which indicates the absence of autocorrelation. Parameter b_0= 305,54 shows the average number of organisations when x_1=x_2=0. Parameter b_1= 0,012 shows that the number of organisations increases to 0.012 units when the increase of the cost of technological product innovation in 2017 at RUB 1 grocery costs, provided that costs for other types of innovation remain the same. Parameter b_2=0.001 shows that the number of organisations increased by 0.001 units. With an increase in the cost of technological process innovation in 2017, 1 RUB is processed costs. This can mean that the size of enterprises is currently suboptimal, and innovation makes them highly productive. The graph of the constructed model is shown in Figure 1.

The Brandon Method was used to construct the multiple nonlinear regression equation.

1. The average value was calculated:

$$\bar{y} = \frac{1}{N} \cdot \sum_{i=1}^{N} y_i \qquad (4)$$

2. Every I-th observation of yi was transformed by the formula:

$$y_{0i} = \frac{y_i}{\bar{y}} \qquad (5)$$

3. For a pair of y_{0i} and x_{i1} variables as with the pair regression, the type of dependence with the maximum specification level according to the Durbin-Watson Criterion and the value of the correlation ratio was chosen (Table 1)

$$\eta : \tilde{y}_0 = f(x_1) \qquad (6)$$

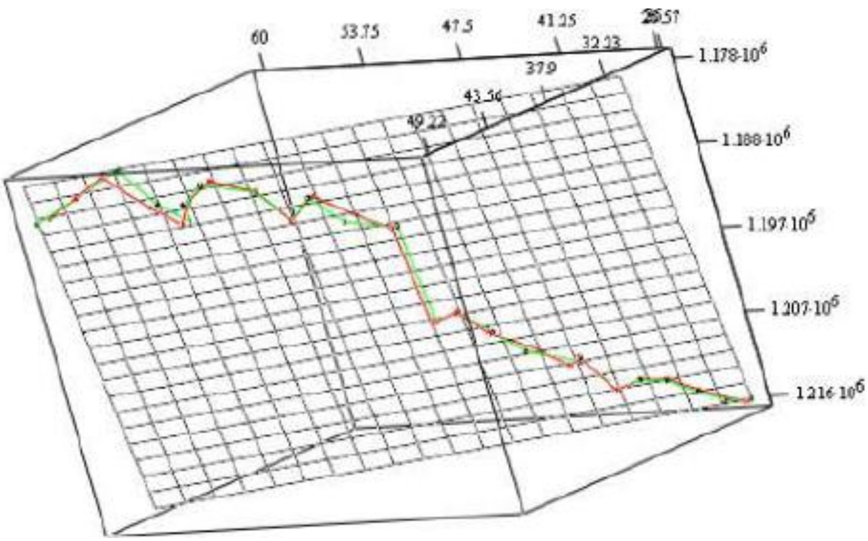

Figure 1: Three-Dimensional Graph of Linear Dependence Y_2 from X_1 X_2

Source: Built by the Authors using Statistica 6 Software Package

Table 1: Pair Regression Equation for $Y_2 X_1$

Regression equation	Coefficients		Significance of coefficients	η	δ	R2	DW
Linear model:	a=	-0.17184	significant	0.9938	1.460	0.988	1.654
	b=	0.00838	significant	significant		significant	none
Hyperbolic model:	a=	2.14964	significant	0.9879	2.251	0.976	0.808
	b=	-156.91859	significant	significant		significant	none
Power model:	a=	0.00285	significant	0.9933	1.581	0.987	1.557
	b=	1.18534	significant	significant		significant	none
The log-log model:	a=	-4.72348	significant	0.9936	1.572	0.987	1.494
	b=	1.16129	significant	significant		significant	none
Parabolic model of order 2:	a=	-0.47041	significant	0.9945	1.375	0.989	1.769
	b=	0.01271	significant	significant		significant	none
	c=	-0.00002	significant				
Parabolic model of order 3:	a=	2.19934	significant	0.9957	1.229	0.991	1.993
	b=	-0.04546	significant	significant		significant	none
	c=	0.00040	significant				
	d=	0.000001	significant				

Source: Compiled by the Authors

Taking into account the significance of regression coefficients, the significance of the equation as a whole, the value of correlation ratio and correlation coefficient (for the linear model) and autocorrelation of residues, we choose a linear model for 2014-15

$$\tilde{y} = 0{,}00838 \cdot x - 0{,}17184 \quad (7)$$

Given the importance of the regression coefficients, the significance of the equation as a whole, the correlation coefficient and the correlation coefficient (for the linear model) and the autocorrelation of the residues, we choose the linear model for 2014-15 $\tilde{y}_{0i}$ and

$$y_{1i} = \frac{y_{0i}}{\tilde{y}_{0i}} \quad (8)$$

For a pair of y_{1i} and x_{i1} variables the type of dependence with the maximum specification level was selected (Table 2):

$$\tilde{y}_1 = f(x_1) \quad (9)$$

Table 2: Pair Regression Equation for Y_2X_2

Regression equation	Coefficients		Significance of coefficients	η	δ	R2	DW
Linear model:	a=	16.809908329	significant	0.9647	3.88	0.931	0.582
		b=	- 0.001320901	significant		significant	positive
Hyperbolic model:	a=	-14.831911891	significant	0.9648	3.91	0.931	0.591
	b=	189469.093779055	significant	significant		significant	positive
Power model:	a=	151.998313889	significant	0.9647	significant	positive	0.659
	b=	-16.189055881	significant	significant			
The log-log model:	a=	149.554727964	significant	0.9648	3.89	0.931	0.586
	b=	-15.820498124	significant	significant		significant	positive
Parabolic model of 2 order:	a=	63.943314643	significant	0.9649	3.99	0.931	0.607
	b=	-0.009192495	significant	significant		significant	positive
	c=	0.000000329	significant				
Parabolic model of order 3:	a=	39996.678183343	significant	0.9580	4.5	0.918	0.728
	b=	-10.008325471	significant	significant		significant	positive
	c=	0.000834875	significant				
	d=	- 0.00000002321632	significant				

Source: Compiled by the Authors

Taking into account the significance of regression coefficients, the significance of the equation in general, the value of correlation ratio and correlation coefficient (for the linear model) and autocorrelation of residues, we choose a linear model for 2016-17

$$\tilde{y} = 16{,}81 - 0{,}001 \cdot x \quad (10)$$

After determining

$$\tilde{y}_{n-1} = f(x_n) \quad (11)$$

a general multiple regression formula is constructed (Table 3):

$$\tilde{y} = \bar{y} \cdot \prod_{k=0}^{n-1} \tilde{y}_k = \bar{y} \cdot \prod_{k=0}^{n-1} f \quad (12)$$

Table 3: Multiple Nonlinear Regression Equation for $Y_2 X_1X_2$

Regression equation	Characteristic	Significance of parameters	n	Importance	δ (%)	Importance	DW	Autocorrelation
Multiple nonlinear model	-0.17184	Significant	0.23	insignificant	16.8 4%	minor	0.368	positive
	0.00838	Significant						
	16.80991	Significant						
	-0.001321	Significant						

Compiled by the Authors

The graph of the constructed model is shown in Figure 2.

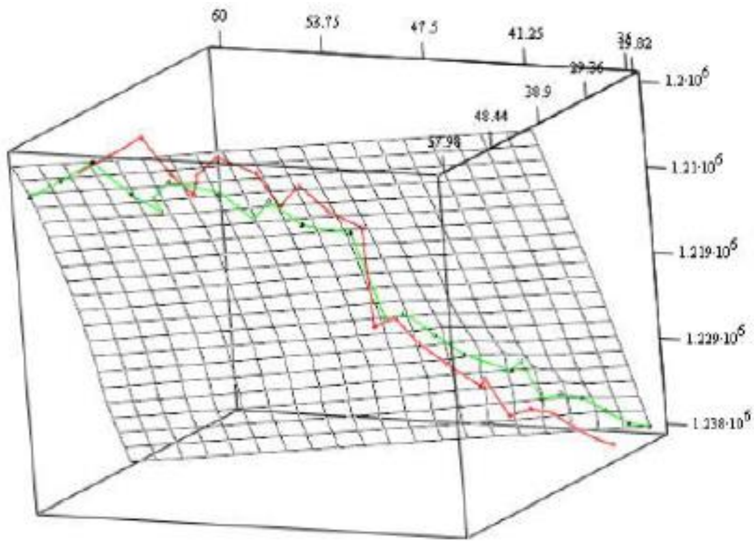

Figure 2: Three-Dimensional Graph of Nonlinear Dependence Y_2 on X_1 X_2
Source: Built by the Authors using Statistica 6 Software Package

Given the importance of regression coefficients, the significance of the equation as a whole, the value of the correlation ratio and correlation coefficient (for the linear model) and autocorrelation of residues, we choose a linear model

$$\tilde{y} = 0,01 - 0,26 \cdot x \tag{13}$$

Calculate the values $\tilde{y}_{0i}$ and

$$y_{1i} = \frac{y_{0i}}{\tilde{y}_{0i}} \tag{14}$$

For a pair of y1i and xi1 variables, the type of dependence with the maximum specification level was selected:

$$\tilde{y}_2 = f(x_1) \tag{15}$$

Given the importance of regression coefficients, the significance of the equation as a whole, the value of the correlation ratio and the correlation coefficient (for the linear model) and autocorrelation of residues, we choose a logarithmic model.

$$\tilde{y} = -17,17062\mathrm{Ln}(x) + 162,53911 \tag{16}$$

After determining

$$\tilde{y}_{n-1} = f(x_n) \tag{17}$$

a general multiple regression formula is constructed:

$$\tilde{y} = \bar{y} \cdot \prod_{k=0}^{n-1} \tilde{y}_k = \bar{y} \cdot \prod_{k=0}^{n-1} f \tag{18}$$

Based on the constructed models (linear and nonlinear), the dependence with the highest level of specification is chosen. The specification of the models is presented in Table 4.

Table 4: Multiple Regressions for $Y_2X_1X_2$. Specifications

Regression equation	Characteristic	Significance of parameters	n	Importance	δ (%)	Significance of equation	DW	Autocorrelation
Multiple linear model	355.99076	significant	0.995	significant	16.11 %	significant	1.573	absents
	0.8618948	significant						
	-0.02949	significant						
Multiple nonlinear model	-0.17184	significant	0.23	insignificant	16.84%	insignificant	0.368	positive
	0.00838	significant						
	16.80991	significant						
	-0.001321	Significant						

Source: Compiled by the Authors

Based on the constructed models, we can conclude that the linear model is more adequate. This model shows what should be the minimum number of enterprises, namely, the critical mass of industry innovation activity which is necessary to create synergy (common innovation field) and there were cooperative network relations between enterprises based on innovation institutions. Conclusions based on the results of the paragraph are that the key trends in the number of organisations are revealed; it is shown that the trends are multidirectional for the stages of the crisis and the rise as well for the conditions of restrictions of sanctions and import substitution; the conclusion is made about the main trends in the distribution of costs for product innovation and the predominance of technological costs and small costs for marketing and organisational innovation and the cost proportions themselves have not changed in the conditions of increasing crisis.

In the future, the results of the described methodology will be used to predict the parameters of industry innovation development, in particular, to predict the number of innovation-active enterprises and their average value as well as the productivity of activities and to verify the resulting coefficients of the regression equation. However, due to the lack of factual material, we use the same methodology as for large companies because the behaviour of large companies reflects the basic statistical laws.

The following is the allocation of cyclical components to small enterprises to study a cyclical number of small innovation organisations. After identification of the periodic component in the time series and its smoothing, simulation of cyclic oscillations is carried out. There are several approaches to modelling cyclic oscillations. One of them is the calculation of the cyclic component values and the construction of an additive or multiplicative time series model.

The trend-cyclic time series is considered

$$(t = \overline{1,n}) \tag{19}$$

for which an additive model of the form is constructed:

$$y_t = u_t + s_t + \varepsilon_t \tag{20}$$

or multiplicative model of the form:

$$y_t = u_t \cdot s_t \cdot \varepsilon_t \tag{21}$$

On ut, it is assumed that this is some smooth function, but the degree of smoothness is unknown in advance. Cyclic component st has a period T0: T0=12 for monthly data and T0=4 for quarterly data. A number of levels n T0 m, where m is a number of months represented in the time series. The additive model is used when the amplitude of cyclic oscillations does not change with time. Otherwise, a multiplicative model is used. Absolute deviations are used as a cyclic component for Sai additive model, for the multiplicative model is Isi index of cyclicity. In this case, the cyclic component should meet certain requirements:

$$\sum_{i=1}^{T_0} S_{ai} = 0 \quad (22)$$

$$\prod_{i=1}^{T_0} I_{si} = 1; \quad (23)$$

Table 5: Cyclic Component for Additive Model		
T 0 m	S_{ai}	$S_{ai\,c}$
1	1.750	0.056
2	2.119	0.425
3	0.060	-1.635
4	2.881	1.187
5	2.190	0.496
6	1.667	-0.028
7	1.976	0.282
8	-0.714	-2.409
T 0 m	S_{ai}	$S_{ai\,c}$
9	2.952	1.258
10	2.143	0.448
11	1.976	0.282
12	1.333	-0.361
∑	20.333	0.000
Source: Compiled by the Authors		

$$S_{ai} = \frac{1}{m} \cdot \sum_{j=1}^{m} (y_{ij} - y_{ij}^{в}); \quad (24)$$

$$I_{si} = \frac{1}{m} \cdot \sum_{j=1}^{m} \frac{y_{ij}}{y_{ij}^{в}}. \quad (25)$$

By the nature of changes in the increments, we select the approximating function (Figure 5-7). The amplitude of the cyclic oscillations is constant, so an additive model is chosen. For the additive model, we calculate the cyclic component, construct a series without the cyclic component (Table 5). We also construct a cyclic wave for the additive model (Figures 3 and 4):

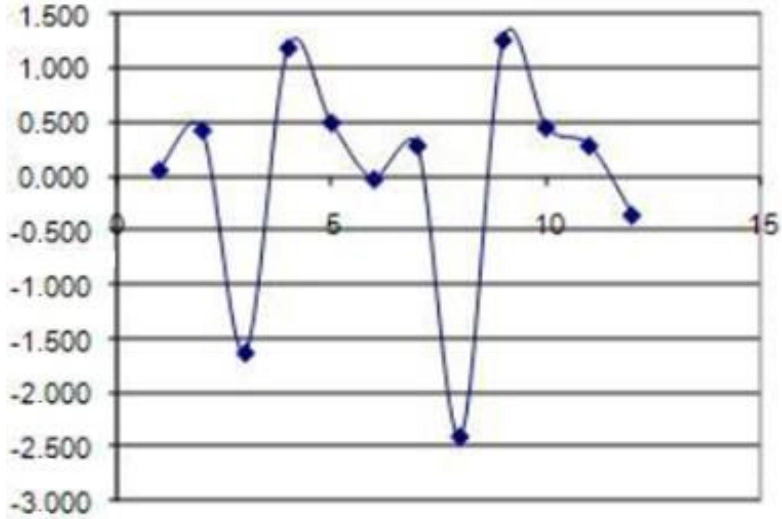

Figure 3: Cyclic Wave for Additive Model
Source: Built by the Authors using Microsoft Office Excel

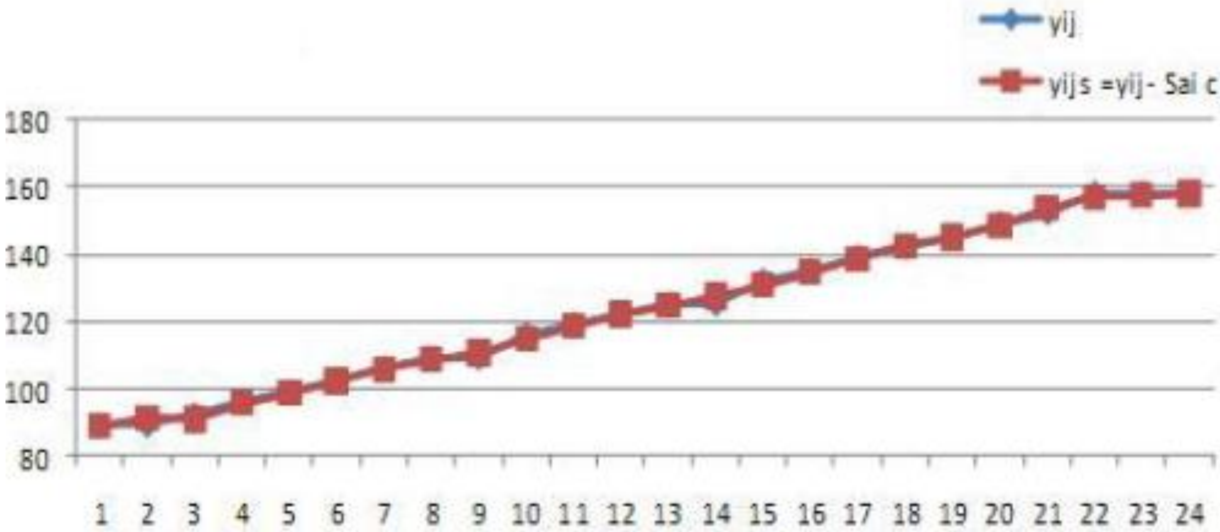

Figure 4: Additive Model
Source: Built by the Authors using Microsoft Office Excel

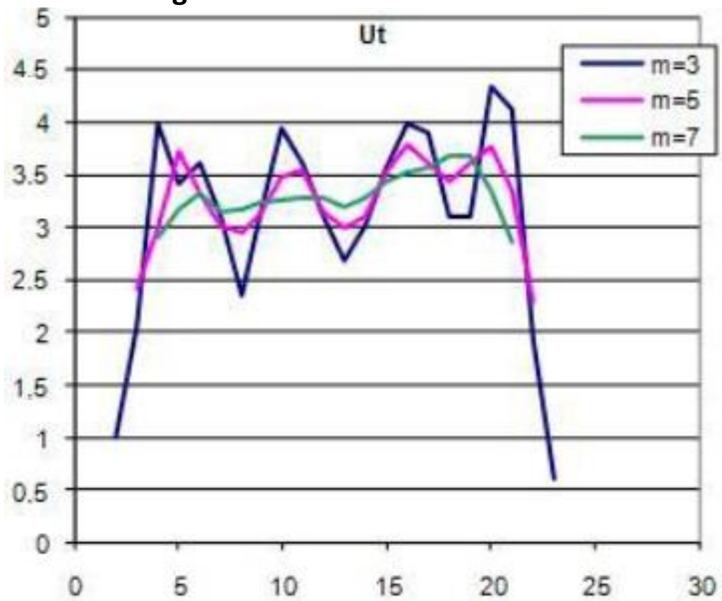

Figure 5: Model U_t
Source: Built by the Authors using Microsoft Office Excel

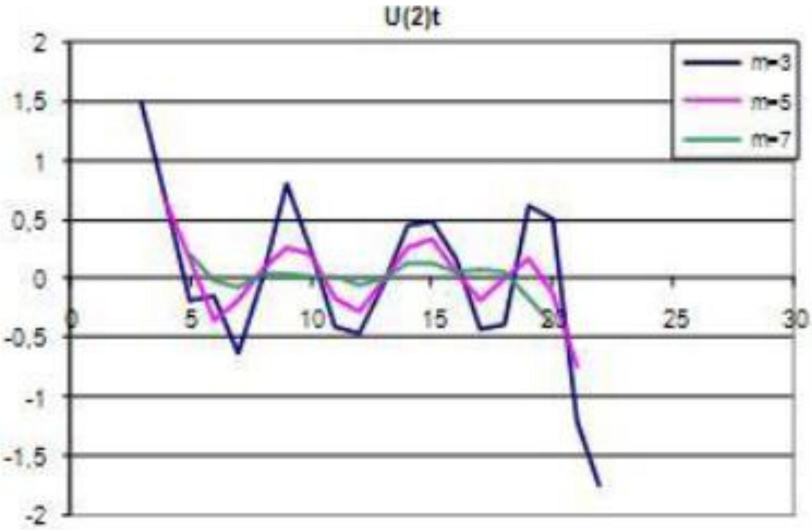

Figure 6: Model $U_t^{(2)}$

Source: Built by the Authors using Microsoft Office Excel

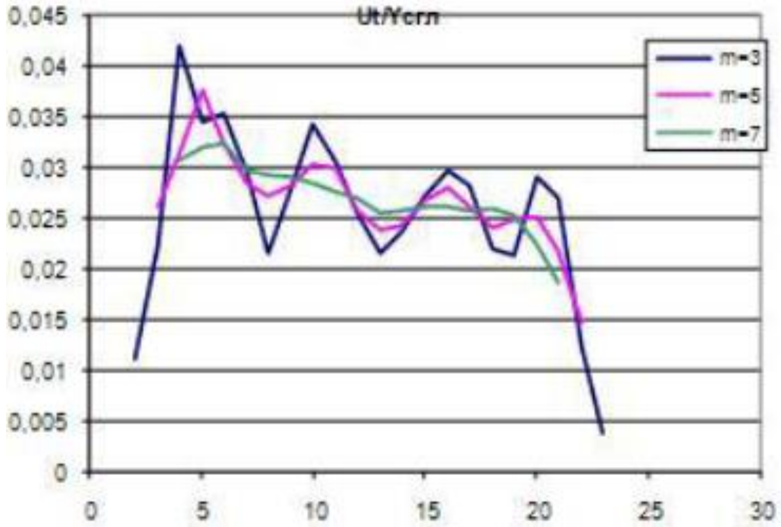

Figure 7: Model $\frac{\overline{U}_t}{\overline{y}_t}$

Source: Built by the Authors using Microsoft Office Excel

Since Ut approximately the same, we build a linear model, Ut(2) linearly changes - we construct a parabola of the third order, $\frac{\overline{U}_t}{\overline{y}_t}$ approximately the same-we build the exponent. As an approximating function of the trend equation for the construction of an additive model, we choose a parabolic model of the 3rd order according to the specification (Table 6).

Based on monthly data based on the additive model, the linear equation is constructed: y=82.96 + 3.249 t, describing the dependence of change of a number of the organisations in time.

Let us give an interpretation of the trend parameters, b=3,249 is an increase in the number of organisations per unit of time, the parameter a = 82.96 does not make any economic sense.

Extrapolation of the trend (the trajectory of the system) is the substitution of the pre-emptive period in the trend equation τ

Table 6. Specification-Based on Additive Trend Model

Regression equation	Coefficients		The significance of the coefficients	η	Δ	R2	DW
Linear model:	a=	82.960144928	significant	0.998	0.827	0.997	0.989
	b=	3.249855072	significant	significant		significant	pos
Exponential model:	a=	86.958040267	significant	0.996	1.121	0.992	0.508
	b=	1.027117490	none	significant		significant	pos
Parabolic model of order 3:	a=	86.256336659	significant	0.999	0.647	0.998	1.284
	b=	1.980058419	significant	significant		significant	mome
	c=	0.113493136	significant				
	d=	-0.002825400	Significant				

Source: Calculated by the Authors

$$\tilde{y}_{n+\tau} = f(n+\tau) \qquad (26)$$

However, this point forecast estimate $\tilde{y}_{n+\tau}$ is insufficient because f (t) approximating function selected by a limited number of levels of the dynamic series and therefore, contains some randomness and the conditions under which the predicted process develops can change over time.

The features of business processes in the innovative activity of organisations of manufacturing industries (weak identification in the development strategy of domestic corporations of the innovative business process, especially, the distribution of costs for the innovative business process revealed uneven distribution, the specifics of the cost structure in the crisis and the traditional situation, small proportions of financing process innovation.). This allows to determine the parameters of future models of innovation and verify the results of forecasts based on them; a balanced approach to the recommendations (Kryukova et al., 2016; Evstratova et al., 2016).

Conclusion

The central aim of this research had been to provide innovative processes in the economic development of the Republic of Tatarstan. To accomplish this, the research developed an economic and mathematical model of factors of activity of innovative-active organisations; model of forecasting the number of innovation-active organisations of manufacturing industries of the Republic of Tatarstan; economic and mathematical model of the network of innovative-active organisations based on the resource centre. Based on the analysis of the distribution of costs between technological, marketing and organisational innovation by types of innovation and economic activities by building an adequate set of statistical models, we have identified the following particularities: the basic internal (directly dependent) and external (indirectly affecting) factors that affect the selected performance characteristics. In order to identify the relations between the cost indicators, modelling and correlation and regression analyses were carried out.

The simulation was carried out for two periods – pre-crisis and crisis. Within the framework of the analysis, cost changes for the leading enterprises of processing industries of the Republic of Tatarstan are simulated. Pair correlation coefficients were calculated to check the presence of multicollinearity between the dependent factorial particularities. Multiple regressions were constructed for linear and nonlinear variables. Autocorrelation was checked. We analysed the relations between the resulting and independent variables (autocorrelation, cyclical and trend) indicating the dependencies in the business processes of innovation.

After analysing the main parameters of innovative organisations and identifying the factors of their mutual impact, the next step was to consider the model of the number of innovative-active organisations as a necessary condition for improving the efficiency of innovation. As a result of modelling the number of innovative-active organisations of the Republic of Tatarstan, there were found significant variables, and the presence of cyclicity was determined. Based on the time series, the number of innovative organisations is predicted.

In order to implement the information support of decision-making management, we have developed an economic and mathematical model of the network of innovative-active organisations based on the industry resource centre. Besides, in the development of the theory of innovation management, we proposed to improve the model of an innovative business process by taking into account the actual phenomenon of the resource centre for the Russian industry, namely, a new model of the Institute of Innovative Development. The existing models are focused mainly on the micro-level, for the Russian conditions, it is somewhat risky and does not always allow to implement the principle of convergence in interaction with the external environment. An economic and mathematical model of factors of activity of innovative-active organisations was developed; model of forecasting the number of innovative-active organisations of manufacturing industries of the Republic of Tatarstan; economic and mathematical model of the network of innovative-active organisations based on the resource centre.

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