Статистика, учет и аудит, 4(95)2024. стр. 52-65
DOI: https://www.doi.org/10.51579/1563-2415.2024.-4.05

Economics and Management
SRSTI: 06.52.35
UDC: 33.2

DEVELOPMENT OF STRATEGY FOR THE REVIVAL AND MODERNIZATION OF SINGLE-INDUSTRY TOWNS OF KAZAKHSTAN BASED ON THE CONSTRUCTION OF A REGRESSION MODEL

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Annotation. *The aim of the study is to develop an effective strategy for the development of single-industry towns in the Republic of Kazakhstan based on the construction of a regression model to improve the quality of life and create comfortable conditions for residents. This study examines the sectors of the economy that need to be developed to achieve economic growth in single-industry towns in Kazakhstan. As a result of regression analysis using the weighted least squares (WLS) method, it was revealed that the improvement of the manufacturing industry makes a significant contribution to the growth of income and the economy of single-industry towns in Kazakhstan, while the effects of R & D sectors are negative. A regression model for the development of single-industry towns has been developed, on the basis of which proposals are given that can be included in the strategy for the development of single-industry towns. The value of the study is that, based on the construction of a regression model, it was concluded that the strategy for the revival and modernization of single-industry towns should include such a direction as the development of the manufacturing industry in Kazakhstan, as this contributes to regional economic growth.*

Key words: *manufacturing industry, research and development (R & D), growth theory, single-industry city, Kazakhstan.*

Main provisions. The study examines the existing strategies for the development of single-industry towns. The current socio-economic development of single-industry towns is analyzed. A conclusion is made about the unsatisfactory state of the socio-economic development of single-industry towns. It is proposed to use territorial marketing tools to increase the attractiveness of single-industry towns and improve the quality of life of the population. A regression model for the development of single-industry towns has been developed, which shows that it is necessary to develop the manufacturing and textile industries for the revival and modernization of single-industry towns. A strategy for the revival and development of single-industry towns is proposed.

Cite this article as: Han-Sol Lee, Tovma N.A., Zobov A.M., Degtereva E.A. Strategy for the revival and modernization of single-industry towns of Kazakhstan based on the construction of a regression model. *Statistics, accounting and audit.* 2024, 4(95), 52-65. DOI: https://www.doi.org/10.51579/1563-2415.2024.-4.05

Introduction. Single-industry towns make a significant contribution to the industrial production of the country, as they are home to large enterprises of the oil and gas, metallurgy, chemical and energy industries. There are 23 city-forming enterprises of the oil and gas, coal, bauxite and iron ore industries in single-industry towns. About 40 percent of the country's industrial output is produced in single-industry towns. In the Republic of Kazakhstan, measures are being taken to develop 20 single-industry towns. As President Kassym-Jomart Tokayev noted, single-industry towns in Kazakhstan have different development prospects: from sustainable economic growth to deep stagnation. Some of them have managed to adapt, for example, the cities of Kentau and Ekibastuz [1]. The Government of the Republic of Kazakhstan is taking specific measures regarding the development of single-industry towns. Four investment projects worth over 100 billion tenge are being implemented, and about 1,000,000 permanent jobs have been created. To ensure a comfortable life in single-industry towns, it is necessary to pay attention to the development of infrastructure, housing, and the availability of educational and medical services. An industrial zone has been created in the city of Saran. It has been ordered to create similar industrial zones in the cities of Khromtau, Satpayev, Balkhash, and Kulsary [2]. In 2023, 56 projects were implemented. Water and heating networks are being reconstructed. Heating networks in Temirtau are being modernized. Water supply networks are being replaced in Shakhtinsk. As a result of economic diversification, the city of Saran, where the Saran industrial zone was launched and is successfully operating in 2021 and a number of large anchor projects have been implemented, has been removed from the category of single-industry towns [3]. Based on official statistics, it can be noted that in modern conditions in single-industry towns there are such problems as: unemployment, low wages, population outflow, underdeveloped infrastructure. The problems of economic development of single-industry towns can be solved by developing a strategy for the development of single-industry towns based on the construction of a regression model showing which areas should be included in the strategy for the development of single-industry towns.

Literature review. Many scientists have studied the development strategy of single-industry towns and investigated single-industry town models. In particular, scientists Barrat T., Sandstrom J., Elem B. studied the development strategies of single-industry towns and came to the following conclusions: firstly, territories in a depressed state require a revision of socio-spatial models; secondly, how time and timing are crucial [4]. Other researchers, in particular Hurd Fioma, Pyer Suzetts studied the factors influencing the development strategy of single-industry towns and, based on the constructed model, came to the conclusion that only labor can influence the well-being of single-industry towns [5]. Scientists Newbury Janet, Gibson Katherine studied promising areas for the development of single-industry towns and, based on the developed model, came to the conclusion about the need to develop political, environmental and economic areas [6].

Scientists Paredes Castellanos, Eugenio, Diaz Casallas, Esperanza, Franco Ávila, Jhon Anderson, Parra Niño, Flor Angela studied various strategies of single-industry towns and came to the conclusion about the need to develop a strategy for the modernization of single-industry towns based on the model of optimal planning of the socio-economic development of single-industry towns in order to create points of economic growth on their basis [7].

Siegel B., Johnson T.J., Alwang J. studied the strategies of single-industry towns based on the model of regional economic diversity and came to the conclusion about the need to diversify single-industry towns [8].

Bozhya-Volya A.A., Popova.A. developed a conceptual model of the ESG impact of socio-economic development indicators on the development strategy of single-industry towns.

Scientists came to the conclusion that if attention is paid to the social aspects of the activity, this helps to increase the attractiveness of labor and expand human potential. If management aspects are developed, this will contribute not only to attracting investors, but also to the expansion of public goods in the city [9].

Antonova I.V., Sokolova V.V., Turgel I.D., Panzabekova A.Zh. developed models that increase the visibility of single-industry towns on the map of economic activity. The resulting models indicate that such indicators as the residual activity of single-industry towns retain the "memory" of the city-forming enterprise. Such "memory" becomes a blocking factor that hinders the economic transformation of single-industry towns [10]. According to Pitukhina M.A., Belykh A.D., they studied the models of single-industry towns development and came to the conclusion that when developing environmental responsibility of enterprises, it is necessary to improve environmental policy and environmental issues should be included in the development strategy of single-industry towns [11].

However, despite the contribution of the above-mentioned scientists, it can be noted that today in Kazakhstan there is no effective model for the development of single-industry towns, on the basis of which it would be possible to build a strategy for the development of single-industry towns. The aim of the study is to develop an effective strategy for the development of single-industry towns in the Republic of Kazakhstan based on the construction of a regression model to improve the quality of life and create comfortable conditions for residents.

Materials and methods of the research. The analytical part of the study is based on the method of regression analysis. The information base of the study was the works of domestic and foreign sources, regulatory documents, data of the agency of the bureau of national statistics. When solving problems, the method of regression analysis was used, which allowed us to develop a model for the development of single-industry towns of the Republic of Kazakhstan and the data of this model allowed us to identify the directions that need to be included in the strategy of economic development of single-industry towns of Kazakhstan.

Results and discussions. Hypothesis. According to the Cobb-Douglas function, the output level is determined by total factor productivity, capital or labor inputs as follows:

$$Y = AL^{\alpha}K^{\beta} \qquad 1)$$

This study focuses on the capital input and capital inputs can be two types. Traditional capital from manufacturing industries and technology and information capital from research and development industry and monocities in Kazakhstan are developing rather than advanced. During the developing stage, traditional capital inputs are more helpful to develop the regional economies rather than technology and information inputs. While, it is apparent that developing R&D sectors can induce multiple spillover effects on other sectors and thereby, its long-term effects may be positive (while the direct effects on developing economies are quite uncertain). In this sense, this study posits that:

Hypothesis 1: The enhancement of manufacturing industries in monocities in Kazakhstan promotes regional economic growth.

Hypothesis 2: The effects of enhancement of research and development industries in monocities in Kazakhstan are ambiguous.

Data and Methodology

For the regression analysis, we constructed econometric models based on the following equation:

$$log(y)\ or\ log(y\_per)_{it} = \beta_0 + \beta_1 man\_rate\ or\ man\_grw_{it} + \beta_2 inno\ or\ inno\_per_{it} + \beta_3 lab_{it} + \beta_4 mig\_grw_{it} + \beta_5 pop\_grw_{it} + \exists_{it} \quad (2)$$

The description of the variables is presented in Table 1. For the robustness, we used two different dependent variables which are log(y) and log(y_per) and four different key variables which are man_rate, man_grw, inno and inno_per. According to the Cobb-Douglas function, we controlled labor inputs which are lab, mig_grw, and pop_grw. i is 19 monocities in Kazakhstan and t is ranged from 2018-2022.

Table 1- Variable Definitions

Notation	Definition
log(y)	The logarithm of industrial output (million tenge, constant values in 2015)
log(y_per)	The logarithm of per capita industrial output (tenge, constant values in 2015)
man_rate	The ratio (%) of manufacturing industrial output to industrial output
man_grw	The growth rate of the manufacturing industrial output
inno	Number of organizations engaged in R&D (units)
inno_per	The per capita number of organizations engaged in R&D (units)
lab	Labor force is divided by population
mig_grw	The growth rate of migration balance
pop_grw	The growth rate of the population
Note: compiled by the authors based on tables 1-4	

Table 2 describes the summary statistics. Dynamics of the variables for the study are additionally attached as Figure A1. As shown in Table A1 (VIF results), our model does not hold an issue of multicollinearity.

Table 2 - Summary Statistics

	log(y)	log(y_per)	man_rate	man_grw	inno	inno_per	lab	min_grw	pop_grw
Mean	10.930	13.869	47.419	0.061	0.316	$2x10^5$	0.550	-12.338	-0.004
Max.	14.253	16.208	98.402	0.749	5.000	$5x10^4$	1.230	32.250	0.086
Min.	7.913	10.725	1.441	-0.795	0.000	0.000	0.253	-897.000	-0.146
Std. Dev.	1.865	1.529	34.728	0.254	1.086	$9x10^5$	0.197	103.410	0.032
Obs.	76	76	76	76	76	76	76	76	76
Note: compiled by the authors									

From the OLS model, the issue of heteroskadascity is found. To resolve this issue, we used a weighted least square (WLS) as a main econometric methodology. From the Breusch–Pagan (BP) test, it is confirmed that "lab" is a main factor to cause heteroskadascity and thereby an inverse variance of this variable is weighted. In addition, figure 1 shows the box-plot of the variables in this study. As can be seen, multiple variables (which are man_grw, inno, inno_per, lab, mig_grw and pop_grw) are showing extreme outliers, which should be resolved in the econometric modelling. In this sense, for the robustness checks, we further adopted the robust least square, which is useful to handle outliers.

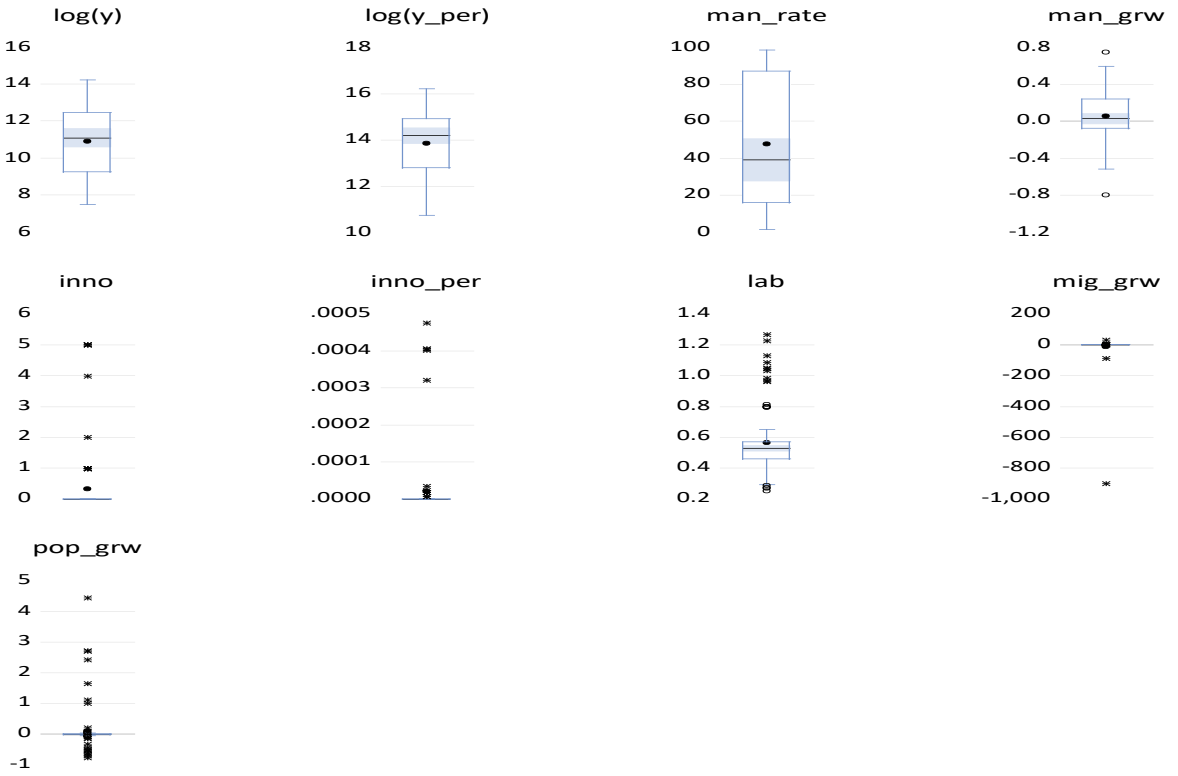

Figure 1 - Box Plot of the Variables in this Study

Note: compiled by the authors based on data from tables 1-4

Table 3 shows the results of WLS regression analysis. As the p-value of BP test is over 0.05 and thereby it indicates that in our model, there is no issue of heteroskadascity. The coefficient of man_rate and man_grw are positive and significant (1% and 5% level, respectively). This indicates that enhancement of the manufacturing industry promotes economic and income growth of monocities. Based on WLS.1. – WLS.4., we can conclude that, in detail, 1% increase in the ratio of manufacturing industrial products to total industrial products will lead to (approximately) 0.02% increase in total industrial products and 1% growth in manufacturing industrial products will lead to (approximately) 0.02% growth in total industrial products. On the other hand, the effects of enhancement of R&D sectors are turned out to be negative and significant at 1% significant level. According to WLS.1. (WLS.3.), increase in one unit of R&D organization will lead to 0.518 (0.597) % decrease in total industrial products. While, WLS.2. (WLS.4.) showed that increase in one unit of per capita R&D organization will lead to 6,734 (7,919) % decrease in total industrial products.

This indicates that enhancement of the R&D capital negatively influences on the economic growth of the monocities in Kazakhstan. In terms of control variables, pop_grw continuously showed a negative and significant coefficient, while the effects of lab are ambiguous. mig_grw is revealed as insignificant.

Table 3 - The results of WLS analysis (1)

Dep. Var.	log(y)			
	WLS.1.	WLS.2.	WLS.3.	WLS.4.
Cons.	9.769***	9.841***	11.906***	11.867***
	(0.752)	(0.746)	(0.535)	(0.523)
man_rate	0.023***	0.022***		
	(0.006)	(0.006)		
man_grw			1.865**	1.832**
			(0.763)	(0.749)
inno	-0.518***		-0.597***	
	(0.167)		(0.174)	
inno_per		-6734.733***		-7919.255***
		(1993.192)		(2051.912)
lab	0.445	0.384	-1.611**	-1.572*
	(0.887)	(0.878)	(0.806)	(0.790)
mig_grw	0.002	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
pop_grw	-14.823**	-15.497**	-12.268*	-13.400**
	(6.198)	(6.153)	(6.468)	(6.381)
P-value of BP test	0.183	0.194	0.804	0.767
Obs.	76	76	76	76
Note: Standard errors are in brackets (*: p<0.1, **: p<0.05, *** p<0.01)				

Table 4 shows the results when the dependent variable is modified to log(y_per) and our results are sustained. The coefficient of man_rate and man_grw are turned out to be positive and significant. Based on Model WLS.5. - WLS.8., it can conclude that 1% increase in the ratio of manufacturing industrial products to total industrial products will lead to (approximately) 0.02% increase in per capita industrial products and 1% growth in manufacturing industrial products will lead to (approximately) 0.014% growth in per capita industrial products.

Table 4 – The results of WLS analysis (2)

Dep. Var.	log(y_per)			
	WLS.5.	WLS.6.	WLS.7.	WLS.8.
Cons.	12.373***	12.415***	13.896***	13.880***
	(0.630)	(0.629)	(0.439)	(0.434)
man_rate	0.016***	0.016***		
	(0.005)	(0.005)		
man_grw			1.448**	1.433**
			(0.627)	(0.620)
inno	-0.237*		-0.294**	
	(0.140)		(0.143)	
inno_per		-3222.013*		-4080.660**
		(1679.049)		(1700.382)
lab	1.479*	1.446*	-0.004	0.016
	(0.743)	(0.740)	(0.662)	(0.655)
mig_grw	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
pop_grw	-12.567**	-13.004*	-10.761**	-11.498**
	(5.193)	(5.183)	(5.314)	(5.288)
P-value of BP test	0.265	0.287	0.604	0.594
Obs.	76	76	76	76
Note: Standard errors are in brackets (*: p<0.1, **: p<0.05, *** p<0.01)				

The coefficient of inno and inno_per also showed the same results: negative and significant. According to WLS.5. (WLS.7.), increase in one unit of R&D organization will lead to 0.237 (0.294) % decrease in per capita industrial products. While, WLS.6. (WLS.8.) showed that increase in one unit of per capita R&D organization will lead to 3,222 (4,080) % decrease in per capita industrial products. In terms of control variables, like the previous models, the effects of lab are ambiguous while mig_grw is insignificant. pop_grw sustained its negative and significant effects.

Table 5 – Results of VIF

man_rate	man_grw	inno	inno_per	lab	min_grw	pop_grw
1.42		1.11		1.39	1.02	1.11
1.44			1.13	1.40	1.02	1.12
	1.03	1.10		1.04	1.01	1.10
	1.03		1.11	1.04	1.01	1.11
Note: composed by authors						

For the robustness checks and to improve the issues with outliers, this study further carried out robust least square regression analysis. As can be seen in Table A2-A3, the main findings from the baseline WLS models are supported in these models. This indicates that to promote manufacturing industry significantly contributes on the growth of economy and income of monocities in Kazakhstan. While, at the current moment, to put an investment in R&D will bring negative effects.

Table 6 – The results of robust least square analysis (1)

Dep. Var.	log(y_per)			
	WLS.5.	WLS.6.	WLS.7.	WLS.8.
Cons.	8.817*** (0.807)	8.893*** (0.808)	11.460*** (0.656)	11.433*** (0.637)
man_rate	0.028*** (0.006)	0.027*** (0.006)		
man_grw			2.277*** (0.869)	2.235*** (0.844)
inno	-0.496*** (0.189)		-0.595*** (0.211)	
inno_per		-6394.016*** (2269.554)		-7922.781*** (2454.960)
lab	1.504 (1.096)	1.427 (1.095)	-0.951 (1.129)	-0.925 (1.096)
mig_grw	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
pop_grw	-15.609** (6.449)	-16.044** (6.468)	-11.975* (7.181)	-13.162* (7.011)
Obs.	76	76	76	76
Note: Standard errors are in brackets (*: p<0.1, **: p<0.05, *** p<0.01)				

In general, we come to the conclusion that priority should now be given to the development of the manufacturing industry, rather than technology or information industries through R & D.

Table 7 – The results of robust least square analysis (2)

Dep. Var.	log(y_per)			
	WLS.5.	WLS.6.	WLS.7.	WLS.8.
Cons.	11.709*** (0.718)	11.723*** (0.699)	13.542*** (0.528)	13.536*** (0.520)
man_rate	0.020*** (0.006)	0.019*** (0.005)		
man_grw			1.759** (0.699)	1.737** (0.689)
inno	-0.241 (0.168)		-0.303* (0.170)	
inno_per		-3242.704* (1961.737)		-4246.427** (2005.266)
lab	2.348** (0.975)	2.347** (0.947)	0.569 (0.908)	0.578 (0.895)
mig_grw	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
pop_grw	-14.128** (5.738)	-14.211** (5.591)	-11.298* (5.776)	-12.160** (5.727)
Obs.	76	76	76	76
Note: Standard errors are in brackets (*: p<0.1, **: p<0.05, *** p<0.01)				

The success of a single-industry town's development largely depends on the ability to coordinate the strategy of the city and the city-forming enterprise. For the development of single-industry towns, it is necessary to develop a single-industry towns development strategy, which will be based on the diversification of the economy, localization of small and medium-sized businesses, creation of small industrial zones, attracting investors, supporting the import of substituting industries, opening new industries. We have developed proposals for the government that can be included in the single-industry towns development strategy of the Republic of Kazakhstan. Thus, a strategy for the revival and modernization of single-industry towns of the Republic of Kazakhstan is proposed (Table 8).

Table 8 – Strategy for the revival and modernization of single-industry towns in the Republic of Kazakhstan based on the construction of a regression model

№	Main areas of activity	Main events
1	The image of the future city	City for comfortable living
2	Industry	Development of the manufacturing industry, in particular the textile industry
3	Production	Formation of a special economic zone of industrial production type
4	Infrastructure development	Development of the "green infrastructure" direction with the aim of restoring the areas of the single-industry town.
5	Development of the social sphere	Improving the quality and accessibility of the social sphere of trade and household services
6	Solving environmental problems	Improving the environmental friendliness of public utilities, solving water problems
7	Technologies	Development of environmentally friendly and energy efficient technologies
8	Digitization	Digital transformation of technical and technological modernization of industry and the agro-industrial complex
9	Increasing the role of public administration	Increasing the role of local government and public organizations in the development of the city
10	Image Marketing	Install a statue in some single-industry towns, for example, like the “Statue of Liberty”, which will enhance the city’s image.
11	Attraction Marketing (Entertainment and Attractions)	Opening of Disneyland for children.
Note: developed by the authors based on the construction of a regression model		

Thus, we believe that in order to revive and modernize single-industry towns in the Republic of Kazakhstan, it is necessary, first of all, to develop the manufacturing industry, in particular the textile industry. Thanks to the development of the textile industry, many cities in Spain and Portugal have been revived and modernized.

Conclusions. Thus, in the course of the study, we come to the following conclusions. To achieve economic development in modern single-industry towns in Kazakhstan, attention should be focused on the formation of industrial capital. From regression analysis, it was revealed that the development of the manufacturing industry significantly contributes to the income and economic growth of single-industry towns in Kazakhstan.

Based on the construction of the regression model, we come to the conclusion that the strategy for the revival and modernization of single-industry towns should include the development of the manufacturing industry, the textile industry, in single-industry towns of Kazakhstan, as this contributes to regional economic growth. On the other hand, the enhancement of research and development capital negatively influences on the income and economic growth.

This is because monocities in Kazakhstan is developing rather than developed and thereby the economic and industrial status of these monocities are not yet reached to well utilize highly advanced capitals. In addition, we come to the conclusion that the main directions for the development of single-industry towns may concern the following aspects: modernization of existing industries with competitive potential, with a special organization for goods with high added value, diversification of the urban economy, primarily through the development of small and medium-sized businesses, the formation of an infrastructure to support entrepreneurship (for example, business incubators, technology parks), motivation of the population, development of human capital, which meets the needs of the local economy, provision of infrastructure, transport and logistics, tourism and recreational and other services for the needs of nearby agglomerations and large cities. The strategy for the development of single-industry towns of the Republic of Kazakhstan must include the principles of territorial marketing, which is aimed at improving the quality of life of people.

Acknowledgement. The article was prepared under the programme BR18574200 "Revival of single-industry towns in the conditions of creation of New Kazakhstan on the basis of territorial marketing" within the framework of programme-targeted financing of the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

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РЕГРЕССИЯ МОДЕЛІН ҚҰРУ НЕГІЗІНДЕ ҚАЗАҚСТАНДЫҚ МОНОҚАЛАЛАРДЫ ЖАҢҒЫРТУ МЕН ЖЕТІЛДІРУДІҢ СТРАТЕГИЯСЫН ДАМЫТУ

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Түйін. *Зерттеудің мақсаты – тұрғындарға қолайлы жағдай жасау мен өмір сүру сапасын арттыру үшін регрессиялық модельді құру негізінде Қазақстан Республикасындағы моноқалаларды дамытудың тиімді стратегиясын әзірлеу. Бұл зерттеу Қазақстанның моноқалаларында экономикалық өсуге қол жеткізу үшін дамуы қажет экономика секторларын зерттейді. Ең кіші квадраттар (ЕКК) әдісін пайдалана отырып регрессиялық талдау нәтижесінде өңдеуші өнеркәсіпті жетілдіру Қазақстанның моноқалаларының табыстары мен экономикасының өсуіне елеулі үлес қосатыны анықталды, ал ҒЗТКЖ секторының әсері анық емес. Моноқалаларды дамытудың регрессиялық моделі әзірленді, оның негізінде моноқалаларды дамыту стратегиясына енгізуге болатын ұсыныстар берілді. Зерттеудің құндылығы - регрессиялық модельді құру негізінде моноқалаларды жаңғырту және жетілдіру стратегиясына Қазақстандағы өңдеу өнеркәсібін дамыту сияқты бағытты қамту керек, өйткені бұл аймақтық экономикалық өсуге ықпал етеді.*

Түйін сөздер: *өңдеуші өнеркәсіп, ҒЗТКЖ, өсу теориясы, моноқалалар, Қазақстан.*

РАЗВИТИЕ СТРАТЕГИИ ВОЗРОЖДЕНИЯ И МОДЕРНИЗАЦИИ МОНОГОРОДОВ КАЗАХСТАНА НА ОСНОВЕ ПОСТРОЕНИЯ РЕГРЕССИОННОЙ МОДЕЛИ

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Резюме. *Целью исследования является разработка эффективной стратегии развития моногородов в Республике Казахстан на основе построения регрессионной модели для повышения качества жизни и создания комфортных условий для жителей. В данном исследовании рассматриваются отрасли экономики, которые нужно развивать для достижения экономического роста моногородов Казахстана. В результате регрессионного анализа с использованием метода наименьших квадратов (МНК) было выявлено, что совершенствование обрабатывающей промышленности вносит существенный вклад в рост доходов и экономики моногородов Казахстана, в то время как эффекты секторов НИОКР неоднозначны. Разработана регрессионная модель развития моногородов, на основе которой даны предложения, которые могут быть включены в стратегию развития моногородов. Ценность исследования заключается в том, что на основе построения регрессионной модели сделан вывод о том, что стратегия возрождения и модернизации моногородов должна включать в себя такое направление, как развитие обрабатывающей промышленности в Казахстане, так как это способствует региональному экономическому росту.*

Ключевые слова: *обрабатывающая промышленность, НИОКР, теория роста, моногорода, Казахстан.*

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Received: 17.09.2024
Accepted: 19.10.2024
Available online: 24.11.2024