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Medium and High-Tech Enterprises of Kazakhstan: Factors of Organization and Development of Innovation

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ABSTRACT

The research of innovation activity of enterprises is found at the nexus of management, economics, public administration, psychology, sociology, and technical sciences. That is because the involvement of people in this process implies a comprehensive assessment of interdependent factors operating at the level of states, industries, regions, enterprises, social groups, and individuals. In the following paper we study the influence of various factors on organization and development of innovation activities at medium and high-tech enterprises of the manufacturing industry of Kazakhstan. The purpose of this study is to analyze the factors affecting the organization and development of innovation at medium and high-tech enterprises in Kazakhstan. Based on correlation and regression analysis we study the following factors: economic development; availability of human capital; quality of the investment environment; features of the economic structure; quality of human capital; innovative development of manufacturing enterprises; scientific potential; quality of the legal environment; availability of financing; state support. We conclude that econometric modeling of innovation at enterprises in Kazakhstan is never a simple task. The study reveals that labor productivity positively affects innovation and competitiveness of enterprises, and that a human capital turns out to be a more important factor of innovation activity of enterprises in Kazakhstan than research and development costs due to their inefficiency.

INTRODUCTION

In the context of globalization and high uncertainty of prices for raw materials, the key driver of socio-economic development is the effective innovative activity. Innovative activity allows enterprises to strengthen their positions and enter new markets. Development of innovative activities can bring additional competitive advantages to enterprises and contribute to the introduction of manufactured products to foreign markets in conditions when the scale of production in the domestic market is limited.

Undoubtedly, the performance of innovative activity largely depends on effective management and organization of this process. State support and measures to stimulate innovation in Kazakhstan have increased over the past decade. However, innovative production still remains low. All this points to the inefficiency of the applied methods and tools for managing and organizing innovation at medium and high-tech manufacturing enterprises in Kazakhstan, which determines the need to find ways to improve them based on the study of factors affecting this process.

The purpose of this study is to analyze the factors affecting the organization and development of innovation at medium and high-tech enterprises in Kazakhstan.

1. LITERATURE REVIEW

Innovative activity of enterprises is an integral part of the socio-economic development of the state and its industries. In this regard, the issue of studying the factors of organization and development of innovation at medium and high-tech enterprises of Kazakhstan appears relevant.

Numerous empirical studies (see Table 1) confirm the importance of the following factors for the organization of innovation activity: the level of economic diversification, research and development costs, the knowledge spillover, the level of human capital.

Table 1. Results of research on factors of innovative activity

Research	*The applied method*	*Dependent variable*	*Level of economic diversification*	*Research and development costs*	*Knowledge spillover*	*Level of human capital*	*Results*
1	2	3	4	5	6	7	8
Jaffe, 1989	Regression	Number of patent applications		+	+		Proves the positive influence of the location of both private and public research centers (knowledge spillover), the key role of research costs
Feldman, Florida, 1994	Regression	New products	+	+	+		Proves the effectiveness of PPP in innovation funding
Bottazzi, Peri 2003	Regression	Number of patents per one involved in innovation	+	+	+		Reveals the reduction of R&D costs in neighboring regions, the distance between which exceeds 300 km
Shterzer, 2005	Regression	Number of patent applications	+	+		-	Positive impact of R&D costs
Leslie, B Ó hUallacháin, 2007	Regression, Least Squares	Number of patents	+	+	+	+	Confirms the importance of human capital compared to the R&D costs

Suslov, 2007	Regression	Share of innovative enterprises			-	+	Reveals the dependence of patent activity on the number of researchers
Mariyev, Savin, 2010	Generalized Method of Moments	Innovative output volume		+	-		Reveals the tendency to regional concentration of innovation, the positive impact of FDI
Arkhipova, Karpov, 2012	Simultaneous equation modeling	Share of innovative enterprises and number of patents		+	+		Reveals the correlation between the level of innovation and patent activity, confirms the importance of research costs
Crescenzi, Jaax, 2015	Regression	International patent applications	+	+	+	+	Reveals the dependence of patent activity on R&D costs
Zemtsov, Muradov, Wade, Barinova, 2016	Regression	Number of commercialized patents, real internal research costs	+	+	+	+	Confirms the dependence of the number of commercialized patents on the quality of human capital, reveals the significance of the R&D costs

Note: Compiled by the authors based on the source (Zemtsov et al., 2016)

Research shows that innovation performance is positively influenced by the R&D costs, level of human capital, level of economic diversification, and the knowledge spillovers. Let us consider other factors affecting innovation performance. The scientific literature has revealed a link between the level of economic development and the level of innovation. However, it is definitely impossible to draw conclusions about its direction. The development of innovative entrepreneurship is facilitated by the growth of GDP and, in particular, GDP per capita as an indicator of the volume of consumer markets, the population solvency and the living standards (Reynolds et al., 1994). A number of studies have revealed that startup activity affects the GDP per capita (Audretsch and Keilbach, 2004; Fritsch and Storey, 2014).

A whole multitude of scientific papers confirm the ambiguity of the impact of unemployment on the entrepreneurial and innovative activity of enterprises (Verheul, 2002; Fritsch and Falck, 2007). Most studies consider unemployment and indicators of foreign and domestic trade as control variables (Dobrynskaya and Turkisch, 2010). For instance, on the one hand, high unemployment may indicate the deterioration of socio-economic conditions and a high failure risk for a startup, and on the other hand, the presence in the economy of a large number of free human resources to engage in forced entrepreneurship. A number of empirical studies conclude that investments have a positive impact on innovation. Global technology giants (Samsung, HP, Apple, Huawei, Google, etc.) invest heavily in R&D, support startups, have research units, and carry out joint innovative projects.

A study of innovation activity in Kazakhstan's conditions requires taking into account peculiarities of the economic structure. In some regions, the share of a raw materials sector is high; these are known as "*raw materials regions*." The dominance of the extractive industry in the economic structure, on the one hand, can cause a "Dutch disease:" a decrease in the economic activity of enterprises and monospecialization leading to a decrease in the level of entrepreneurial and innovative activity (Raposo and Do Paço, 2011). On the other hand, regions with a raw-material economy enjoy higher incomes of the population, which means a higher purchasing power, ultimately contributing to the growth of mass entrepreneurship in the service sector.

The indicator of concentration and quality of human capital is the level of education of the population. This indicator also demonstrates informal rules and norms in society. Through the education system, the government can affect the development of creative entrepreneurship and innovative activity (Djankov, 2009). Training and introduction of advanced training courses for the population contribute to the acquisition by individuals of necessary competencies to engage in innovative entrepreneurship (Nielsen, 2014; Lee et al., 2004; Anokhin and Schulze, 2008). This is why the study needs to consider this

indicator. Legal environment has a direct impact on innovation activity. Level of corruption, level of consumer and producer rights protection, and the number of economic crimes have a direct impact on the safety of innovative entrepreneurship (Xheneti and Bartlett, 2012; Yakovlev and Zhuravskaya, 2013; Aparicio et al., 2015).

The high bank interest rate is one of the main reasons for limiting the access to funding of innovative projects (EBRD, 2014). Aparicio's research shows the positive impact of simplified access to loans on startup activities of enterprises. A 2014 EBRD study reveals a negative correlation between innovation activity and limited access to bank loans (Seitzhanov et al, 2020). We conclude that a negative correlation does not necessarily mean that restricting access to bank loans leads to a decrease in innovation. Such a causal relationship between credit restrictions and innovation activity takes the opposite direction: commercial banks more willingly fund innovation activities and reduce credit restrictions if this process is successful (as in innovation emerges). Thus, the review of scientific literature has revealed a number of factors of innovation, which we shall be further investigating in detail to build an econometric model:

- Economic development (GDP, GDP per capita, inflation rate, exports, imports, salaries, labor productivity, exchange rate);
- Availability of human capital (population, employed population, unemployment rate);
- Quality of investment environment (investments in fixed assets, investments in the manufacturing industry, direct investment);
- Features of the economic structure (the share of extractive industry in GDP, professional, scientific and technical activities);
- Quality of human capital (life expectancy of the population at birth, the average expected duration of education during the coming life);
- Innovative development of manufacturing enterprises (innovative sales volume, innovation costs);
- Scientific potential (internal R&D costs, number of organizations engaged in R&D, number of employees engaged in R&D);
- Quality of legal environment (crime rate);
- Availability of funding (bank lending to the economy, loans issued to processing enterprises through STBs, the amount of loans issued by Damu EDF to processing enterprises, the weighted average interest rate of banks on loans issued);
- State support (the amount of funding of industrial and innovative development program documents.)

In accordance with the purpose of the study and based on the analysis of scientific literature, we have formulated the following hypotheses on the influence of factors on the organization and development of innovation activities of medium and high-tech manufacturing enterprises in Kazakhstan.

- *H1. Innovation of enterprises in Kazakhstan resists econometric modelling.*
- *H2. Labor productivity has a positive impact on innovation and competitiveness of enterprises.*
- *H3. Human capital is a more important factor of innovation in Kazakhstan than the R&D costs due to their inefficiency.*

2. RESEARCH METHODOLOGY

For the purposes of this paper, we selected small and medium-sized enterprises of medium and high-tech manufacturing industries as the object of research. We used the OECD methodology to determine medium and high-tech enterprises. According to the OECD, manufacturing enterprises are profiled according to the intensity of research and development costs, that is, according to the ratio of R&D costs to value added. We have identified the following groups of manufacturing enterprises: high, medium, and low-tech industries. Currently, the OECD classification is widely recognized and used in most international

organizations and countries, including the Bureau of National Statistics of Kazakhstan for statistical observation. High-tech manufacturing enterprises include the following types of activities:

- Production of computers, electronic and optical products;
- Production of other vehicles;
- Production of motor vehicles, trailers and semi-trailers;
- Repair and installation of machinery and equipment;
- Production of machinery and equipment;
- Production of chemical industry products;
- Production of electrical equipment.

Medium-tech industries include the following types of activities:

- Production of rubber and plastic products;
- Production of finished metal products;
- Production of other non-metallic mineral products;
- Metallurgical industry;
- Production of coke and refined petroleum products;
- Production of basic pharmaceutical products.

Based on the analysis of scientific literature, we are to select the innovative output volume as the effective indicator of innovation in medium and high-tech manufacturing industries. As benchmarks, the study uses an extensive list of factors that can affect innovation: economic development, quality of the investment environment, quality of the legal environment, features of the economic structure. Table 2 shows the main factors and variables of economic and mathematical model. To assess the factors of organization and development of innovation in medium and high-tech manufacturing industries, we shall use correlation and regression analysis as our main method of research.

Table 2. Factors and variables of economic and mathematical model

Factors	*Legend*	*Variables*	*Source*
1	*2*	*3*	*4*
Economic development	GDP	Gross domestic product by production method, million tenge	BNS
	GDP_capita	GDP per capita, tenge	
	Infl	Inflation, %	BNS
	Export	Turnover in foreign currency (export), million US dollars	BNS
	Export_ products	Export of non-raw (processed) products, million US dollars	BNS
	Import	Turnover in foreign currency (import), million US dollars	BNS
	Salary	Average monthly salary of the core staff, thousand tenge	BNS
	Labor_ product	Labor productivity, thousand tenge	BNS
	Exchange_rate	Average annual exchange rate of the US dollar	NB RK
Availability of human capital	Popul	Population at the end of the period (year), thousand people	BNS
	Employed_pop	Employed population, thousand people	BNS
	Unempl	Unemployment rate, %	BNS
Quality of the investment environment	Invest	Investments in fixed assets, million tenge	BNS
	Manufact_invest	Investments in fixed assets of the manufacturing industry, billion tenge	BNS
	Direct_invest	Direct investments, million US dollars	NB RK
Features of the economic structure	Industry_GDP	Share of the extractive industry in GDP, %	BNS
	Prof_activ	Professional, scientific and technical activities, %	BNS

Quality of human capital	Life_expect	Life expectancy of the population at birth, years	BNS
	School_expect	Average expected duration of training during the coming life	UN HDI
Innovative development of manufacturing enterprises	Sold_ innovprod	Innovative sales volume, million tenge	BNS
	Cost_innov	Innovation costs, million tenge	BNS
Scientific potential	R&D_costs	Internal R&D costs, million tenge	BNS
	Enterp_numb	Number of organizations (enterprises) engaged in R&D, units	BNS
	Employees_numb	Number of employees engaged in R&D, people	BNS
Quality of the legal environment	Crime_level	Crime rate (per 10,000 people)	BNS
Availability of funding	Bank_lend	Bank lending to the economy, million tenge	NB RK
	Loans	Loans issued to processing enterprises through STBs, billion tenge	Damu EDF
	Loans_Damu	Amount of loans issued by Damu EDF to processing enterprises, total	Damu EDF
	Interest_rate	Weighted average interest rate of banks on loans issued	NB RK
State support	Funding	Amount of funding of industrial and innovative development program documents, billion tenge	SPFIID, SPIID-1

Notes:

- Compiled by the authors.
- BNS: Bureau of National statistics, Agency for Strategic planning and reforms of the Republic of Kazakhstan
- NB RK: National Bank of the Republic of Kazakhstan
- HDI UN: the UN's Human Development Index
- Damu EDF: Damu Entrepreneurship Development Fund JSC
- SPFIID, SPIID-1: State programs of (forced) industrial and innovative development

Accordingly, a set of factors and indicators of the object of research development in modern conditions, a comprehensive analysis using qualitative and quantitative methods of scientific research and logical conclusions are the important elements of assessing the factors of organization and development of innovation in medium and high-tech manufacturing industries.

3. RESULTS

At the initial stage of our study, we chose the indicator Level of innovation activity of enterprises of medium and high-tech manufacturing industries as a dependent variable. We have built a correlation matrix in SPSS Statistics. The subsequent analysis of the correlation matrix showed that the level of innovation in medium and high-tech manufacturing industries has a correlation relationship with only two following variables: a) With an indicator of the number of organizations (enterprises) engaged in R&D (0.82), and b) With the crime rate indicator (0.78). We have also established a weak correlation with the rest of the variables selected for analysis. To further model the processes of innovation in medium and high-tech manufacturing industries, we chose the innovative output volume as a dependent variable. We chose the following factors and their variables as independent indicators affecting the dynamics of innovation activity indicators of medium and high-tech manufacturing enterprises:

- Economic development with indicators: GDP, GDP per capita, inflation rate, exports, imports, salaries, labor productivity, exchange rate.
- Availability of human capital: population, employed population, unemployment rate.
- Quality of the investment environment: investments in fixed assets, investments in the manufacturing industry, direct investment.
- Features of the economic structure: the share of the extractive industry in GDP, professional, scientific and technical activities.

- Quality of human capital: life expectancy of the population at birth, average expected duration of education during the coming life.
- Innovative development of manufacturing enterprises: innovative sales volume, innovation costs.
- Scientific potential: internal R&D costs, number of organizations engaged in R&D, number of employees engaged in R&D.
- Quality of the legal environment: crime rate.
- Availability of funding: bank lending to the economy, loans issued to processing enterprises through STBs, amount of loans issued by Damu EDF to processing enterprises, the weighted average interest rate of banks on loans issued.
- State support: the amount of funding of program documents of industrial and innovative development.

Statistical data on selected indicators is available, previously studied as part of the scientific project AP09058009 "Assessment and development of mechanisms for stimulating innovation activity of manufacturing enterprises in Kazakhstan based on the methodology of foresight and technological road mapping."For a more comfortable calculation, we have coded the selected indicators appropriately (Table 2). Table 3 shows descriptive statistics of the variables taken for analysis.

Table 3. Descriptive statistics

	Average	*Standard deviation*	*N*
Activ_level	18,436	3,7300	11
GDP	40667505,964	16413063,2458	11
GDP_capita	2316130,345	835573,2606	11
Infl	7,227	2,4113	11
Export	62616,745	18339,2134	11
Export_ products	15844,301	2514,9162	11
Import	35619,317	7632,1453	11
Salary	130,645	46,1592	11
Labor_ product	7985,255	3180,7948	11
Exchange_rate	230,841	97,0183	11
Popul	17394,641	779,3751	11
Employed_pop	8450,430	255,6742	11
Unempl	5,264	,5278	11
Invest	7245436,364	2650903,7237	11
Manufact_invest	746,909	269,1620	11
Direct_invest	23021,364	3463,6967	11
Industry_GDP	15,764	2,5208	11
Prof_activ	4,382	,3060	11
Life_expect	70,979	1,9308	11
School_expect	14,936	,3042	11
Innov_product	352245,373	277357,6030	11
Sold_ innovprod	396532,127	250324,2152	11
Cost_innov	357734,273	340920,1754	11
R&D_costs	59493,218	15481,1832	11
Enterp_numb	387,000	25,8147	11
Employees_numb	21340,727	3209,3894	11
Crime_level	159,480	50,1335	11
Bank_lend	7777616,909	2345931,0454	11
Loans	1038,636	471,5677	11
Loans_Damu	202,082	73,5013	11
Interest_rate	12,745	1,9460	11
Funding	486,733	384,1032	9

Note: Compiled by the authors based on SPSS Statistics data

Table 3 shows the following average values for the sample:

- Innovative activity of enterprises of medium and high-tech manufacturing industries – 18.4%.
- Innovative output volume – 352,245 million tenge.
- Innovative sales volume – 396,532 million tenge.
- Innovation costs – 357,734 million tenge.
- GDP by production method – 40,667,505.9 million tenge.
- GDP per capita – 2,316,130.3 tenge.
- Labor productivity – 7,985.2 thousand tenge.
- Investments in fixed capital of the manufacturing industry – 746.9 billion tenge.
- Bank lending to the economy – 7,777,616.9 million tenge.

Average expected duration of education during the coming life is 14.9 yearsTo assess the degree of closeness between the dependent variable and the independent variables taken for analysis, we used the Pearson correlation coefficient. We have built a correlation matrix in SPSS Statistics (Table 4).

The analysis of the correlation matrix showed that the volume of innovative output by enterprises of medium and high-tech manufacturing industries in Kazakhstan has - A very high correlation with the following variables:

- GDP (0.82).
- GDP per capita (0.82).
- Labor productivity (0.84).
- Employed population (0.80).
- Investments in fixed assets (0.83).
- Innovative sales volume (0.96).
- A high correlation with the following variables:
- Inflation (0.68).
- Average monthly salary of the core staff (0.77).
- Population at the end of the period (year) (0.73).
- Average annual exchange rate of the US dollar (0.70).
- Investments in fixed assets of the manufacturing industry (0.78).
- Average expected duration of education during the coming life (0.74).
- Bank lending to the economy (0.75).

In addition, the analysis of the correlation matrix showed that the volume of innovative output by enterprises of medium and high-tech manufacturing industries has an average correlation with the following variables:

- Loans issued to manufacturing enterprises through second-tier banks (0.45).
- Crime rate (per 10,000 people) (0.59).
- Internal R&D costs (0.63).
- Life expectancy of the population at birth (0.66).

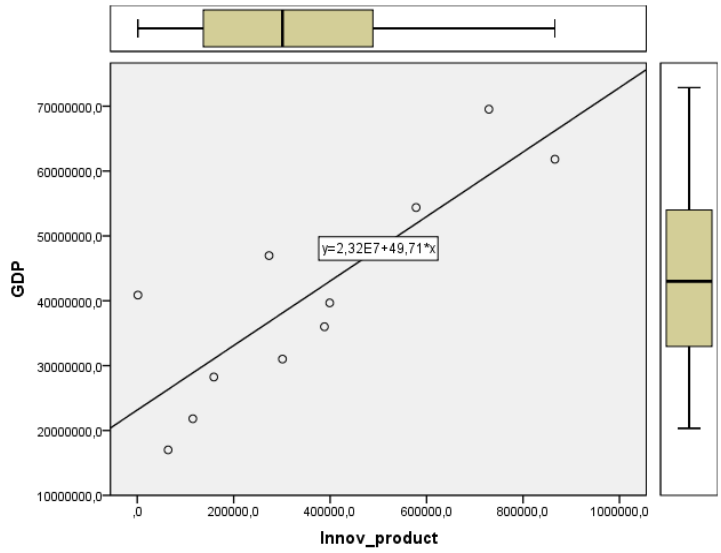
As for the rest of the selected variables, correlation is very weak and we shall not be considering them in further studies.

The simplest method of visualizing the relationship between selected variables is constructing scattering graphs (Figures 1).

Table 4. A correlation matrix

	Innov_product	GDP	GDP_capita	Infl	Export	Export_ products	Import	Salary	Labor_ produc	Exchange_rat e	Popul	Employed_po p	Unempl	Invest	Manufact_inv est	Direct_invest
Innov_product	1	,840	,840	-,588	,089	,265	,229	,803	,854	,709	,764	,774	-,605	,849	,812	,337
GDP	,840	1	,999	-,130	-,212	,066	-,003	,996	,998	,917	,975	,886	-,820	,975	,948	-,052
GDP_capita	,840	,999	1	-,128	-,190	,090	,017	,994	,998	,908	,977	,899	-,836	,968	,949	-,042
Infl	-,588	-,130	-,128	1	-,415	-,361	-,474	-,073	-,167	-,051	,015	-,175	-,110	-,195	-,055	-,758
Export	,089	-,212	-,190	-,415	1	,901	,886	-,278	-,199	-,534	-,291	,150	-,106	-,270	-,249	,749
Export_ products	,265	,066	,090	-,361	,901	1	,807	,002	,086	-,235	-,007	,419	-,391	-,025	,002	,759
Import	,229	-,003	,017	-,474	,886	,807	1	-,051	,003	-,352	-,091	,353	-,218	-,047	-,068	,650
Salary	,803	,996	,994	-,073	-,278	,002	-,051	1	,992	,933	,983	,871	-,811	,971	,952	-,113
Labor_ produc	,854	,998	,998	-,167	-,199	,086	,003	,992	1	,921	,967	,886	-,811	,976	,942	-,006
Exchange_rate	,709	,917	,908	-,051	-,534	-,235	-,352	,933	,921	1	,914	,691	-,635	,918	,876	-,199
Popul	,764	,975	,977	,015	-,291	-,007	-,091	,983	,967	,914	1	,880	-,857	,921	,974	-,182
Employed_pop	,774	,886	,899	-,175	,150	,419	,353	,871	,886	,691	,880	1	-,939	,792	,854	,174
Unempl	-,605	-,820	-,836	-,110	-,106	-,391	-,218	-,811	-,811	-,635	-,857	-,939	1	-,686	-,803	,001
Invest	,849	,975	,968	-,195	-,270	-,025	-,047	,971	,976	,918	,921	,792	-,686	1	,913	-,044
Manufact_invest	,812	,948	,949	-,055	-,249	,002	-,068	,952	,942	,876	,974	,854	-,803	,913	1	-,131
Direct_invest	,337	-,052	-,042	-,758	,749	,759	,650	-,113	-,006	-,199	-,182	,174	,001	-,044	-,131	1

	Innov_product	Industry_GDP	Prof_activ	Life_expect	School_expec t	Sold_ innovprod	Cost_innov	R& D_costs	Enterp_numb	Employees_n umb	Crime_level	Bank_lend	Loans	Loans_Damu	Interest_rate	Funding
Innov_product	1	-,391	,165	,710	,792	,965	,255	,682	-,329	,357	,148	,782	,537	,376	-,364	-,434
Industry_GDP	-,391	1	-,779	-,887	-,771	-,579	-,689	-,882	,429	-,865	-,843	-,834	-,902	-,803	-,272	,766
Prof_activ	,165	-,779	1	,607	,566	,290	,803	,563	-,346	,482	,631	,542	,697	,638	,180	-,502
Life_expect	,710	-,887	,607	1	,896	,840	,649	,959	-,309	,743	,587	,948	,928	,654	,221	-,896
School_expect	,792	-,771	,566	,896	1	,893	,409	,942	-,509	,688	,552	,972	,881	,709	-,091	-,716
Sold_ innovprod	,965	-,579	,290	,840	,893	1	,315	,825	-,381	,516	,312	,899	,692	,490	-,233	-,584
Cost_innov	,255	-,689	,803	,649	,409	,315	1	,483	-,104	,412	,465	,463	,625	,455	,354	-,623
R&D_costs	,682	-,882	,563	,959	,942	,825	,483	1	-,428	,805	,646	,978	,939	,731	,138	-,830
Enterp_numb	-,329	,429	-,346	-,309	-,509	-,381	-,104	-,428	1	-,533	-,668	-,442	-,342	-,550	,483	-,082
Employees_numb	,357	-,865	,482	,743	,688	,516	,412	,805	-,533	1	,916	,749	,726	,876	,211	-,611
Crime_level	,148	-,843	,631	,587	,552	,312	,465	,646	-,668	,916	1	,578	,620	,832	,124	-,297
Bank_lend	,782	-,834	,542	,948	,972	,899	,463	,978	-,442	,749	,578	1	,912	,740	-,010	-,800
Loans	,537	-,902	,697	,928	,881	,692	,625	,939	-,342	,726	,620	,912	1	,695	,232	-,919
Loans_Damu	,376	-,803	,638	,654	,709	,490	,455	,731	-,550	,876	,832	,740	,695	1	-,011	-,490
Interest_rate	-,364	-,272	,180	,221	-,091	-,233	,354	,138	,483	,211	,124	-,010	,232	-,011	1	-,662
Funding	-,434	,766	-,502	-,896	-,716	-,584	-,623	-,830	-,082	-,611	-,297	-,800	-,919	-,490	-,662	1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40000000,0
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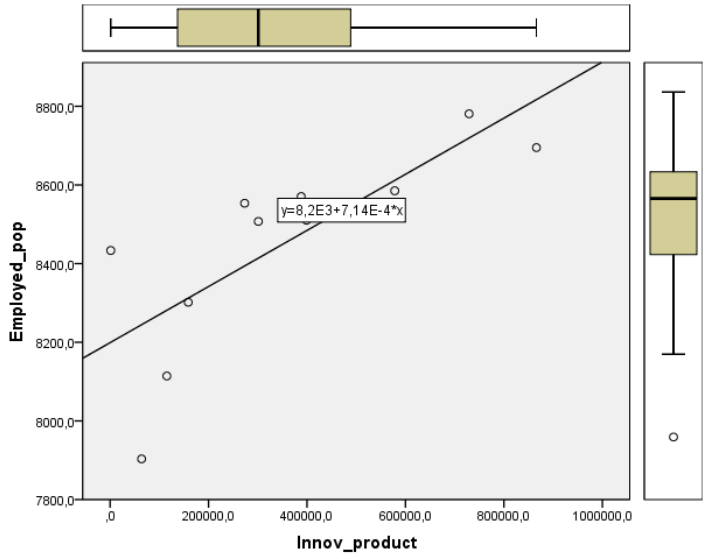
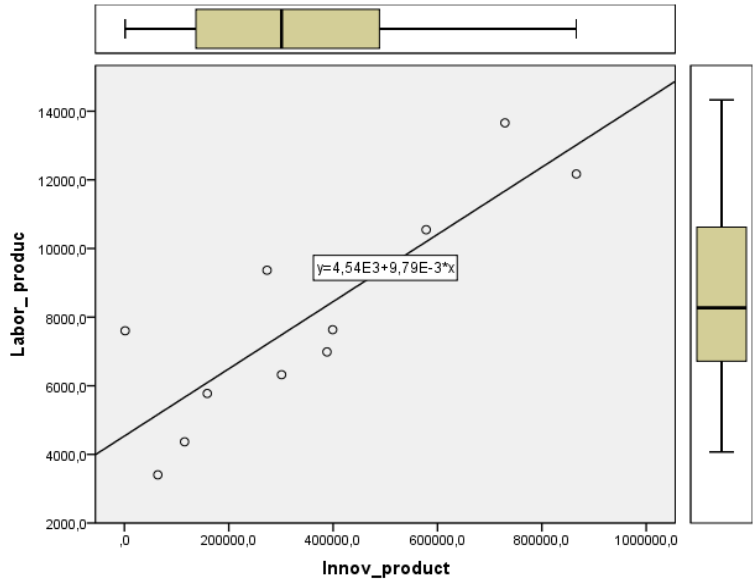
Innov_product


Employed_pop
8800,0
8600,0
8400,0
8200,0
8000,0
7800,0
y=8,2E3+7,14E-4*x
,0
200000,0
400000,0
600000,0
800000,0
1000000,0
Innov_product


Labor_produc
14000,0
12000,0
10000,0
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Innov_product

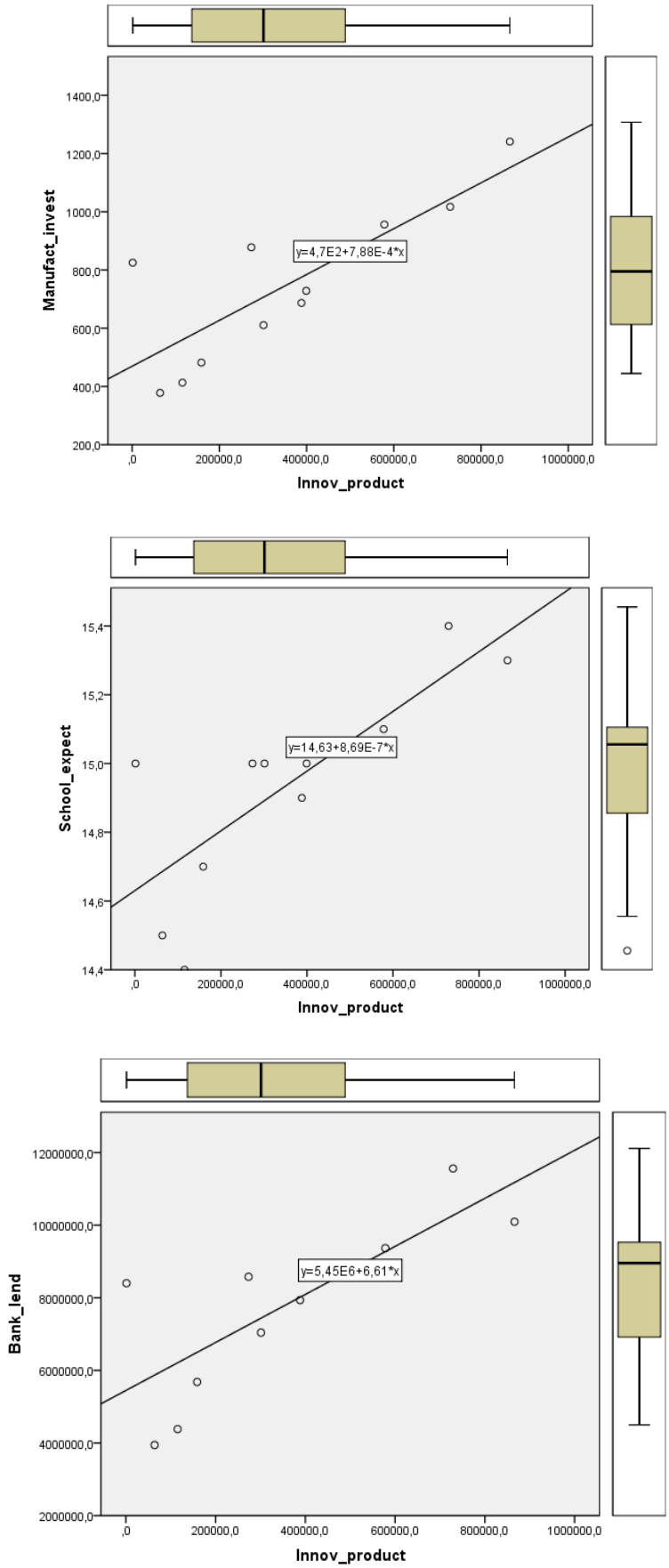

Figure 1. Scattering graphs between independent and dependent variables

A dependent variable Volume of innovative output has a positive correlation with the following indicators: GDP; GDP per capita; Labor productivity; Employed population; Investments in fixed assets; Innovative sales volume; Average monthly salary of core staff; Investments in fixed assets of manufacturing industry; Population at the end of the period; Bank lending to the economy; and Average expected duration of training during the coming life.

The correlation between variables Volume of innovative output by medium and high-tech manufacturing industries and Inflation is negative.

Both independent and dependent variables displayed on the scattering graphs have a linear type of dependence, which further allows us to construct a linear multiple regression equation.

The analysis of the correlation matrix (Table 4) showed a close correlation between the volume of innovative output by enterprises of medium and high-tech manufacturing industries with GDP and GDP per capita (multicollinearity), which excludes the possibility of including these two factors in the regression model. Indicators of a paired correlation of labor productivity and GDP have similar values, i.e. they depend on each other. In this regard, for the further construction of the regression model, we chose one factor - Labor_product.

Next, using the statistical data analysis package within SPSS Statistics, we have calculated the parameters of correlation and regression analysis (Table 5).

Table 5. Results of correlation and regression analysis

Model summary

Model	*R*	*R-Square*	*R-Square adjusted*	*Standard estimation error*	*Variation statistics*				
					R-Square variation	*F variation*	*Degree of freedom 1*	*Degree of freedom 2*	*Sig. F variation*
1	,951[b]	,904	,880	96175,2517	,904	37,584	2	8	,000

ANOVA[a]

Model		Sum of squares	Degree of freedom	Mean square	F	Significance
1	Regression	695274967134,069	2	347637483567,035	37,584	,000[b]
	Excess	73997432317,493	8	9249679039,687		
	Total	769272399451,562	10			

Coefficients[a]

Model		*Unstandardized coefficients*		*Standardized coefficients*	*t*	*Significance*	*Correlations*		
		B	*Standard error*	*Beta*			*Zeroth-order*	*Partial*	*Component*
1	(Invariable)	−237901,454	81680,194		−2,913	,020			
	Labor_product	138,844	19,400	1,592	7,157	,000	,854	,930	,785
	Loans	-499,265	130,858	−,849	−3,815	,005	,537	−,803	−,418

Excess statistics

	Minimum	*Maximum*	*Mean*	*Standard deviation*	*N*
Projected value	37347,762	814556,250	352245,37	263680,671	11
Excess	−105641,835	140687,843	,0000	86021,7602	11
Standard projected value	−1,194	1,753	,000	1,000	11
Standard excess	−1,098	1,463	,000	,894	11

Note: Compiled by the authors based on SPSS Statistics data

a) Dependent variable: Innov_product
b) Predictors: (invariable), Loans, Labor_ product

Table 5 shows that correlation coefficient R = 0.85. This indicates a close linear relationship between regression model variables. Coefficient of determination r2 = 0.90 shows that linear equation of multiple regression explains 90% of the variance of the influence of independent variables, and the volume of innovative output of enterprises of medium and high-tech manufacturing industries accounts for 10%.

A linear multiple regression equation can represent the general view of the model:

$$Innov\_product = -237901 + 138\ Labor\_product - 499\ Loans \quad (1)$$

where:

Innov_product is the volume of innovative output of enterprises of medium and high-tech manufacturing industries in million tenge;

Labor_product is labor productivity is thousand tenge;

Loans are loans issued to manufacturing enterprises through STBs in billion tenge.

Evaluating the quality of the multiple regression equation using the Fisher criterion allows us to recognize the statistical significance of the equation:

$$F = 37{,}584;\ F_{table.} = 2{,}61\ (F_{fact} > F_{table}) \quad (2)$$

Table 5 shows that the following actual values of t-statistics (Student's t-criterion):

$$t_a = -2{,}91;\ t_b = 7{,}15;\ t_c = -3{,}81 \quad (3)$$

demonstrate statistical significance of the regression model parameters and the indicator of the connection closeness (modulo $t_a > t_{table}$, $t_b > t_{table}$, $t_c > t_{table}$).

The constructed regression model allows us to conclude the following:

- With an increase in labor productivity by each unit, the value of the variable innovative output volume increases by 138 units.
- A decrease in the indicator of loans issued to manufacturing enterprises through STBs by each unit will lead to an increase in the innovative output volume of enterprises of medium and high-tech manufacturing industries by 499 units.

4. RESULT DISCUSSIONS

Modeling the innovation processes did not allow to reject any of the suggested research hypotheses.

For the initial stage of our study, we chose the level of innovation activity of enterprises of medium and high-tech manufacturing industries as a dependent variable. However, it showed a correlation with only two variables: number of organizations (enterprises) engaged in R&D and crime rate. In this regard, for further modeling of the processes of organization and development of innovation, we chose the innovative output volume as a dependent variable.

Productivity is the defining concept of the phenomenon of competitiveness while improving national competitiveness appears impossible without productivity and innovation (Carayannis and Grigoroudis, 2016). Consequently, at both macro and micro levels, productivity is closely related to competitiveness and innovation, as it is a key factor in accumulation and increase of national income. Depending on the level of analysis, the strength of the relationship between competitiveness, productivity and innovation may vary, but the existence of such a relationship in economics is generally recognized (Carayannis and Campbell, 2010).

Previous studies (Kurmanov et al., 2016; 2019) have shown that significant amounts allocated from the republican budget for measures to support and stimulate innovation activities of manufacturing enterprises have zero effect. Innovation cost efficiency (2.7% in the best years) and the share of innovative

products in GDP (1.6%) remain extremely low. Kazakhstan still lags behind many developed and a number of developing countries in terms of innovative output and sales. In other words, performance of innovative activity of manufacturing enterprises still remains low. Our research also confirms the inefficiency of R&D costs.

Thuswise, we have confirmed the bigger importance of labor productivity in innovation and competitiveness of enterprises (H1), as well as a more positive impact of human capital than research and development costs (H1). We feel important to note that statistical data on medium and high-tech industries of Kazakhstan shows gaps associated with incomplete information. As a result, econometric modeling of innovation at enterprises in Kazakhstan is not easy (H3).

Our study reveals that a decrease in the indicator of loans issued to manufacturing enterprises through second-tier banks by each unit leads to an increase in the innovative output volume in enterprises of medium and high-tech manufacturing industries by 499 units. In this case, EBRD expert conclusions (EBRD, 2014) that restricting access to bank loans leads to a decrease in the innovation appear true. However, such a causal relationship between credit restrictions and innovation requires further research.

CONCLUSION AND RECOMMENDATIONS

A dynamic and successful innovation activity at knowledge-intensive enterprises requires a wide application of modern methods and technologies for organizing this process, including the coordinated and simultaneous use of scientific, technological, personnel, financial, and other policies.

The focus of most modern research is to create favorable conditions for innovation, as well as to study the management mechanisms of the organization of all stages of the innovation process: from the idea to the final innovative product. However, despite a fairly large number of studies devoted to innovation, it is necessary to note a gap in the methodology of organizing innovation in entrepreneurship, in particular, in the methodology for assessing the factors of organization and development of this process in Kazakhstan.

Numerous studies show that encouraging of innovation activity at the enterprise level requires a competent innovation policy contributing to a chain reaction of creation and implementation of innovations at macroeconomic level. The result of this process is an increase in competitiveness.

Further research will focus on identifying the causal relationship between credit restrictions and innovation activities of medium and high-tech manufacturing enterprises in Kazakhstan.

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