Identifying the Relation between the Factors Contributing to the Economic Efficiency of Investments in the Industrial Sector of the RA

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ՀՀ տնտեսության արդյունաբերության ոլորտում ներդրումների տնտեսական արդյունավետությանը նպաստող գործոնների և դրանց միջև կապերի բացահայտումը

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Ամփոփում. Հոդվածի ուսումնասիրության *առարկան* է համարվում Հայաստանի Հանրապետության արդյունաբերության ոլորտում ներդրումների տնտեսական արդյունավետությունը, իսկ *նպատակն* է այդ ոլորտում ներդրումների արդյունավետությունը նպաստող գործոնների միջև կապերի բացահայտումը և դրանց միջոցով ներդրումային արդյունավետ ուղղություններ փնտրելը: Վերլուծությունը իրականացվել է երկու փուլով. առաջին փուլում առանձնացվել են արդյունաբերության ոլորտի չորս ենթաճյուղերը և հետազոտվել են դիտարկվող ժամանակահատվածում այդ ոլորտներում արդյունահանվող ապրանքների ծավալների հետ բարձր կոռելացվածություն ունեցող ցուցանիշները, մասնավորապես՝ ներդրումային հոսքերը: Ինչը հիմք է հանդիսացել հետազոտության երկրորդ փուլում որպես ներդրումների արդյունավետության ցուցանիշի համարժեք գործոն դիտարկել արդյունաբերական արտադրանքի ծավալների ցուցանիշը: Այստեղ իրականացվել է արդյունաբերության ոլորտի բոլոր ենթաճյուղերում արդյունաբերական արտադրանքի ծավալների և դրանց հետ բարձր կոռելացվածություն ունեցող գործոնների ուսումնասիրությունը:

Արդյունաբերության ոլորտը հանդիսանալով երկրում արտահանման ուղղվածություն ունեցող տնտեսության ճյուղ, դիտարկվում է նաև որպես արտահանման ներուժի առաջխաղացման հիմք: Այս առումով արտահանումը նույնպես դիտարկվել է որպես ներդրումների արդյունավետությանը նպաստող գործոն:

Կոռելացիաների հաշվարկը առաջին փուլում իրականացվել է ռանկային կոռելացիայի ցուցանիշի միջոցով տասնմեկ տարիների տարեկան ցուցանիշի հիման վրա: Իսկ երկրորդ փուլում նշված ժամանակահատվածի ամսական ցուցանիշների հիման վրա հաշվարկվել են Պիրսոնի կոռելացիայի ցուցանիշները, որոնք կլաստերային խմբավորման մեթոդով բաժանվել են խմբերի, և կատարվել է յուրաքանչյուր խմբի նշանակության առանձին ուսումնասիրություն:

Հանգուցաբառեր` արդյունաբերական պոտենցյալ, ներդրումների ներգրավում, ներդրումներ, արդյունահանում, կլաստերային վերլուծություն

Выявление факторов, влияющих на экономическую эффективность инвестиций в промышленный сектор экономики РА и связи между ними

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Анотация: *Предметом* исследования статьи является экономическая эффективность инвестиций в промышленный сектор Республики Армения, а *целью* является выявление связей между факторами, способствующими эффективности инвестиций в этот сектор и поиск эффективных инвестиций. Анализ проводился в два этапа. На первом этапе были выделены четыре подотрасли промышленного сектора и исследованы показатели с высокой корреляцией с объемом продукции, добытой в этих отраслях за рассматриваемый период, в частности, инвестиционные потоки. Что послужило основанием для рассмотрения индекса объемов промышленного производства в качестве эквивалентного фактора показателя эффективности инвестиций на втором этапе исследования. Здесь проведено исследование объемов промышленной продукции по всем подотраслям промышленности и факторов, имеющих с ними высокую корреляцию.

Являясь экспортоориентированной отраслью экономики страны, промышленный сектор также рассматривается как основа для продвижения экспортного потенциала. В этом отношении экспорт также рассматривается как фактор, способствующий эффективности инвестиций.

Расчет корреляций на первом этапе проводился с использованием индекса ранговой корреляции на основе годового индекса одиннадцати лет. А на первом этапе были рассчитаны индексы корреляции Пирсона на основе

месячных показателей указанного периода, которые были разделены на группы методом кластерной группировки, и проведено отдельное исследование значимости каждой группы.
Ключевые слова: промышленный потенциал, привлечение инвестиций, инвестиции, добыча, кластерный анализ

Introduction: Industry is considered to be one of the major sectors of the economy of countries exporting industrial products. It generally requires medium to large scale initial investments and very long payback period. This is the main reason why industrial investments are mainly consolidated in developed countries with relatively stable ecnomies. After the collapse of the Union of Soviet Socialist Republics, all member-countries went into a deep industrial crisis. Hence, the investment in Armenian industrial sphere only resumed in the last twenty years. However, this sector is still sensitive to crises. This sector is growing slowly, due to a number of reasons: limited export routes, low domestic consumption (directed to the consumption of imported goods due to low cost price), lack of technical-technological equipment, lack of specialized labor and wages and many more. The development and promotion of investment activities in this sector is crucial for the Armenian economy, as Industry accounts for a significant share of country's GDP (20.1% as of 2020).

Attracting investment is one of the most important ways to increase the productivity of the economy. At the current stage of Armenia's development, foreign investements and export capacity growth are vital form the perpective of financial resources, new technologies, management experience and market development.

Effective investments contribute technological and human resource development. As of March 2021, the demand for human capital in industry is only 17.4% of the demand (the sector with the highest demand for labor). In other words, as a significant factor for the study, it is expedient to consider the strength of the relationship between the average monthly nominal salary of workers in the sector and the volume of industrial output.

The sphere of industry, the second branch of the economy by the volume of lending by the commercial banking system of the Republic of Armenia, makes 16% of the total lending volumes (as of the end of the first quarter of 2021). Lending volumes (used in the study) are considered to be one of the factors that may have a high correlation with extractive products output volumes.

As noted, the industry is considered the field of export promotion, so here we can also to take into account the foreign exchange rate factor (the average monthly rate of dram to dollar, the relationship with other currencies was assumed to be insignificant).

Methodological approach
a. Methods for identifying relationships between factors
The monthly and annual data covering a period of 2010-2021 used for the survey was collected from the Statistical Committee and the Central Bank of the Republic of Armenia (RA).

The article differenciate four sub-sectors of industry
- Mining and quarrying (Mining),
- Manufacturing,
- Electricity, gas, steam and air conditioning supply (Electricity),
- Water supply, sewerage, waste management and remedlation activities (Water supply).

In the first stage, a study of industrial production volumes, gross foreign investment flows (hereinafter referred to as investments), lending volumes by commercial banks of the RA (hereinafter referred to as lending volumes), annual dynamics of volumes in GDP in these four sub-sectors. Then, among the mentioned indicators, the construction of the correlation matrix by means of the Spearman rank correlation coefficient is considered, and their significance is checked. The rank correlation index considers the relationship between of the variables in the dataset (used when the number of views is 11). In other words, it is not the data that is considered, but the order of each data in a row. This indicator shows the correlation between the two ranks which are used to estimate the strength of the connection between them. Rank correlation is calculated by the general correlation formula and has the same properties, but for already regulated series.

In the *second stage*, to determine the correlation between the factors, their monthly indicators for the last eleven years are taken into account using Pearson's correlation coefficient and using the correlation matrix.

Pearson correlation is the ratio of the covariance between two variables to the product of their standard deviations. It is rated in the [-1.1] range. The indicator reflects the linear dependence between the two variables, which implies that it ignores the other factors influencing the variables [**15**; **16**].

b. Methods of clustering identified links
After identifying the correlations, the cluster method is used to analyze their grouping and individual groups. Here the determination of the optimal cluster, the arrangement of the indicators

and the visualization of the groups is obtained by using the corresponding packages and formulas used in the R program(corrplot, pkgs, ggplot).

Factors contributing to the efficiency of investments in industry: In order to consider the

strength of the factors contributing to the growth of the volumes of industrial production, a number of indicators of the RA economy are taken into account, for which the following notations are made:

Exp -	RA export volumes,
ExR -	AMD / USD exchange rate,
GMin -	Volumes of the Mining industry sub-sector in GDP,
GMan -	Volumes of the Manufacturing industry sub-sector in GDP,
GElc -	Volumes of the Electricity industry sub-sector in GDP,
Gwat -	Volumes of the Water supply industry sub-sector in GDP,
IMin -	Investment flows in Mining industry sub-sector,
IMan -	Investment flows in Manufacturing industry sub-sector,
IElc -	Investment flows in Electricity industry sub-sector,
IWat -	Investment flows in Water supply industry sub-sector,
SMin -	Average monthly nominal salary in the Mining industry sub-sector,
SMan -	Average monthly nominal salary in the Manufacturing industry sub-sector,
SElc -	Average monthly nominal salary in the Electricity industry sub-sector,
Swat -	Average monthly nominal salary in the Water supply industry sub-sector,
VMin -	Production volumes in the Mining industry sub-sector,
VMan -	Production volumes in the Manufacturing industry sub-sector,
VElc -	Production volumes in the Electricity industry sub-sector,
VWat -	Production volumes in the Water supply industry sub-sector,
LMin -	Lending volumes in the Mining industry sub-sector,
LMan -	Lending volumes in the Manufacturing industry sub-sector,
LElc -	Lending volumes in the Electricity industry sub-sector,
LWat -	Lending volumes in the Water supply industry sub-sector.

The connection between the investment environment of the industry and volumes of industrial output:

When describing the relationship between investments and product volumes in industry, the gross inflows of foreign investment in all four sub-sectors of industrial production are studied, as well as the GDP and volumes of loans provided by commercial banks in each sub-sector.

During the observed period (2010-2021, credit investments in 2011-2021), the directions of growth / decrease of investments in industry sub-sectors differ from each other. However, during the 2020 crisis, there was a decline in investment in all sub-sectors (except Water supply sub-sector).

Loan investments have been growing in all sub-sectors, but in 2020 there was a restraint in the growth rate, as in the Armenian banking system the

lending policy was restraint pursued due to the crisis.

At the same time, the production volumes in the sub-sectors, due to the mentioned observations, as well as due to the limitations of the COVID-19 epidemic, registered a decline, in some cases (Mining sub-sector) a weakening of the growth rate.

Although the volume of production has decreased due to the crisis, the share of industry in GDP has increased compared to previous years, amounting to 20% of total GDP. This is primarily due to the decline in overall GDP, especially in the relatively larger weakening of activity in other major sectors (Trade and Services sub-sector). (Figure 1.)
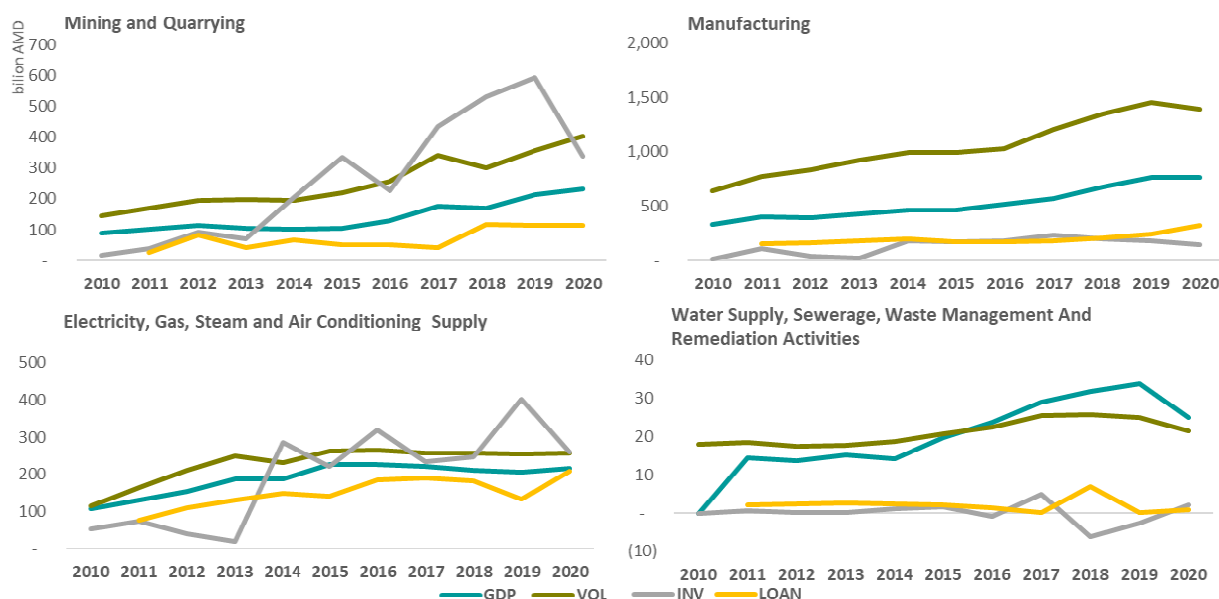
Figure 1. *Dynamics of GDP production, Investments, Lending Volumes in the Sub-Sectors of Industy of the RA Economy in 2010-2020.*

Figure 1 shows that investment flows during these years have mainly taken place in the Electricity sub-sector. However, based on the output of the Manufacturing sub-sector, as well as from the point of view of ensuring continuous economic growth, a policy aimed at promoting investments in this sub-sector has always been implemented in Armenia. Also it is important to promote the export potential of industrial products in order to launch competitive products in the international market.

The Spearman or rank correlation coefficient is used to characterize the relationship between these indicators. Below is the ranking correlation matrix, which is calculated in the industry sector, between the volumes in the GDP of each sub-sector, the volumes of products produced, and investments.

correl matrix	GMIN	GMAN	GELECT	GWAT	VMIN	VMAN	VELECT	VWAT	IMIN	IMAN	IELECT	IWAT
GMIN	1.00	0.84	0.59	0.85	0.93	0.86	0.59	0.67	0.85	0.46	0.51	0.04
GMAN		1.00	0.63	0.92	0.95	0.99	0.63	0.85	0.92	0.69	0.80	(0.05)
GELECT			1.00	0.65	0.72	0.64	0.95	0.67	0.69	0.65	0.53	0.25
GWAT				1.00	0.91	0.90	0.70	0.88	0.92	0.65	0.62	(0.15)
VMIN					1.00	0.95	0.70	0.77	0.90	0.58	0.64	0.08
VMAN						1.00	0.64	0.82	0.94	0.68	0.78	(0.06)
VELECT							1.00	0.71	0.69	0.65	0.50	(0.01)
VWAT								1.00	0.86	0.85	0.73	(0.12)
IMIN									1.00	0.75	0.68	(0.06)
IMAN										1.00	0.68	0.08
IELECT											1.00	(0.15)
IWAT												1.00

Table 1. *The Strength of the Relationship Between Investments, Volumes in GDP and the Volumes of Products Produced by the Sub-Sectors of the Industry*

The indices observed in Table 1 were calculated according to the data in Figure 1. Only those correlations that were considered significant (p-value <0.05) were considered valid for the study.

Table 1 shows that the correlation between investment and volume of output is high and positive, which in turn has a high positive correlation with volume of industry in GDP.

In almost all sub-sectors of the industry, significant correlation was registered between the investment volumes and GDP in each sub-sector's industrial output volumes, except for the investment volumes of the Water supply sub-sector, as the volumes of industrial output in this sector are very small: 0.4% share in GDP.

The correlation between investments in the Electricity sub-sector, as well as the volume of products produced, Mining and the same indicators of the Manufacturing sub-sectors is assessed as significantly high-positive as the structure of electricity consumption in industry is mostly in these sectors.

Study of the links between the factors contributing to the production of industrial products: From Table 1 we see that there is a high correlation between industrial output, investments and GDP volumes in the sub-sectors of industry. Therefore, in order to determine the effectiveness of investments, we should observed the analysis of the

factors contributing to the volumes of industrial production, revealing the relationship between them.

In other words, the favorable conditions of the factors contributing to the growth of industrial production will lead to the growth of production, which, in turn, will create an investment attractive, favorable and efficient investment environment for investors. Conversely, investment activity leads to an increase in industrial output, which in turn leads to an increase in economic activity. Thus, we can say that this process takes place on the principle of rotation (circulation).

Here are separated the following factors in industry, which are highly correlated with the increase in the production volumes of each sub-sector:

• average monthly nominal salary of employees in the given sector;

• credit investments provided by Armenian commercial banks in this sphere,

• export volumes,

• average monthly exchange rate (dram to dollar).

Through the correlation matrix between the volumes of products produced in each sub-sector and these indicators, it can be seen that the factors really have a high degree of correlation. To show the latter, the monthly indicators of all the above-mentioned factors are observed from December 2011 to March 2021 (the series includes 112 observations). In this case, the Pearson correlation coefficient is considered to characterize the relationships between the factors.

In Figure 2, all the circles shown in blue show a positive correlation between the two factors. Conversely, if the circle is red, there is an inverse relationship between the indicators. The darker the circle, the stronger the correlation between the indicators [2].
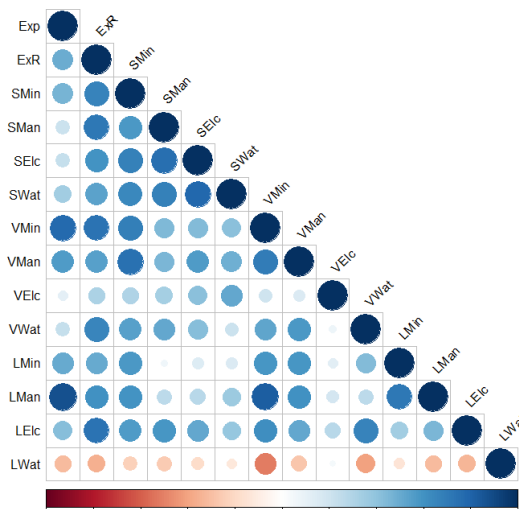

Figure 2. *Correlation Matrix of the Products Produced in the Sub-Sectors of the RA Economy and the Factors Contributing to Their Growth*

Since these numbers of correlations are 14, not all links can be interpreted, so these indicators can be grouped to simplify the analysis.

In the study, grouping is performed by the cluster partitioning clustering method. Partitioning clustering are clustering methods used to classify observations in a data set into multiple groups based on their similarity. Algorithm requires to specify the number of clusters to be generated. Elbow, Average Silhouette and Gap Statistic methods are used to determine the optimal number of clusters (Figure 3.)
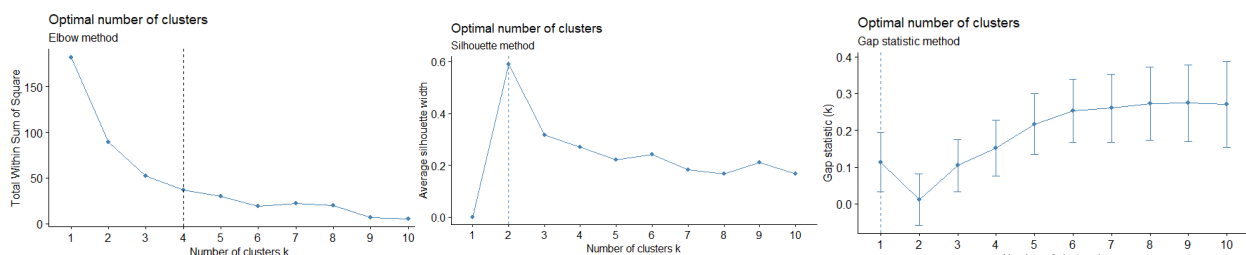

Figure 3. *Three Methods Used to Determine the Optimal Number of Clusters*

From the three methods obtained in Figure 3, it is advisable to use the Elbow method in the study, where the optimal number of clusters is four, because, using the other two methods, an optimal number of clusters was obtained one or two [**3**]. In the third case, the value k = 1 means one whole group, which is meaningless in terms of group separation. In case k = 2, as a result of the observation, the second group of correlation indicators is selected as the outlier indicator (the correlation of the crediting volumes in the Water supply sub-sector with itself). This is the same as in k = 1 case.

Since the optimal number of cluster groups was selected as a result of the application of the mentioned methods, k = 4, for further analysis it is possible to get the visualization of the groups in the following form:
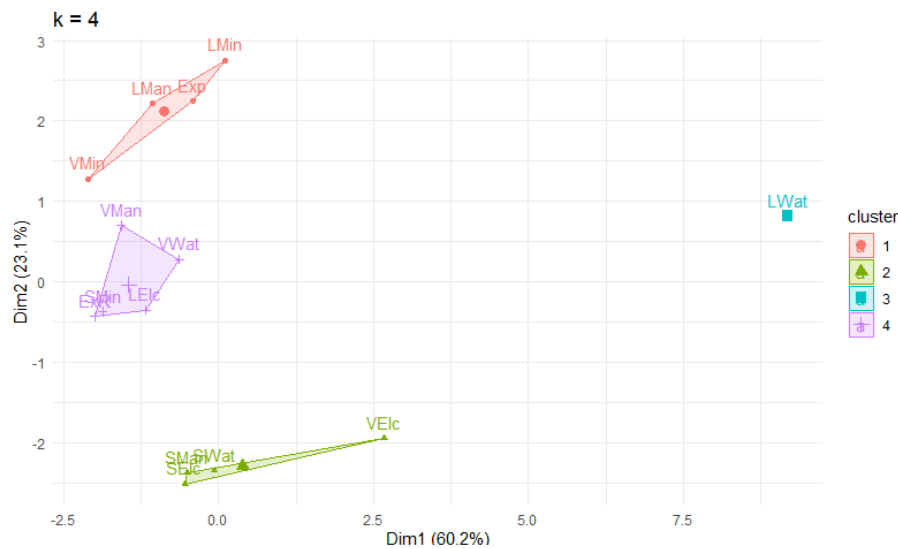

Figure 4. *In the Case of k = 4, Grouping of Highly Correlated Indicators*

The different clusters in Figure 4 show the groups of correlations between the observed indices that can be viewed separately [**1**].

Dim1+Dim2=83.3% means that this data accounts for 83.3% of the total variation (ie, the newly created data in Figure 4 explains 83.3% of the original data).

Cluster 1 is based on correlations between exports, mining production, mining and manufacturing lending volumes. This means that the indicators in this group indicate a similar behavior of the connection strength. As mentioned, export volumes largely depend on the volume of mining products, which in turn has a high correlation with the volume of lending in this sub-sector. The fact that the lending in the manufacturing industry is included in the group of correlation indicators is due to fact that the nature of the correlations here is similar to the volume of lending to the Mining industry.

The main correlations in Cluster 2 are with the average monthly nominal salary of employees in the sectors. This is because the average monthly nominal salary of employees in these sectors in the country increases or decreases at the same time, proportionally.

Cluster 3 is an outlier, which is not interpretable in practice.

Cluster 4 includes the average monthly AMD / USD exchange rate, the average monthly nominal salary in the mining industry, the volume of products produced in the Manufacture and Water supply sub-sectors, and the volume of lending in the Electricity sub-sector. The fact, that the exchange rate and the products produced in the Manufacture industry is in the same group is explained based on that the primary raw materials of the products are mainly imported and the main part of the products is exported, as a result the income from their sale is received in foreign currency. Therefore, the effectiveness of investments made here is also due to exchange rate fluctuations. As mentioned, most of the mining products are exported, ie the income received here is also mostly in foreign currency, so the nature of the correlation of employees' salaries coincides with the nature of the currency correlation. And the similarity of the correlation of lending volumes in the Electricity sub-sector with other factors of the group is due to the fact that lending in this sector is mostly in foreign currency.

Conclusion: From the cluster groups it can be concluded that industrial production growth in the two main spheres, which is Mining and Manufacture sub-sectors have a high correlation with the lending by the commercial banks of the RA, as a result of increasing export volumes. Also the average

monthly nominal salary of employees in the sub-sectors are highly correlated with the production volumes.

In other words, from the point of view of the efficiency of investments in industry, it is appropriate to direct investments in the main growth spheres, in the Manufacture and the Mining sub-sectors.

A stable precondition for effective investment growth in the industrial sector is a stable macroeconomic environment, in particular, a stable price level - predictable exchange rate dynamics, which will exclude fluctuations in the exchange rate of the Armenian Dram, which may undermine the price competitiveness of Armenian goods and services in the international market.

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